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Sewage Disposal Investigations at Cleveland

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SYNOPSIS—Preparatory to the design of sewage-treatment works for Cleveland, Ohio, a series of tests is being made of various methods of treating the sewage. The causes leading up to the decision to treat the sewage and to make the tests before building the proposed works are outlined and then the testing station is described. The station includes grit chambers, screens and tanks for preliminary treatment; rapid filters or scrubbers, sprinkling filter, auxiliary settling tanks, and a disinfection plant for final treatment; tanks for dilution studies; sludge digestion tanks and sludge-drying beds, and an office and laboratory.

In Engineering News, of Mar. 28, 1912, J. M. Estep, assistant chief engineer, Department of Public Service, described the development of the Cleveland intercepting sewer system from the time when it was commenced in 1897. In the present article, therefore, the writer will but briefly discuss the present sewer system, taking up only those features which have special reference to the sewage-treatment problem.

On July 25, 1905, the city appointed a commission of experts, consisting of Rudolph Hering, George H. Benzenberg and Desmond FitzGerald to study the general question of improved water-supply and sewerage for the city. This commission, about six months later, submitted a report in which was recommended:

(1) The extension of the water-works tunnel to a point about four miles from the shore.

(2) The construction of an intercepting sewer system to collect the sewage from the entire city and discharge the same into Lake Erie, at a point about 10 miles east of the Cuyahoga River. This intercepting sewer was to be designed to carry twice the dry-weather flow from one million people, on the basis of 200 gal. per capita, or a total of 400 gal. per capita per day. This plan involved several overflows into the lake and river to take care of the discharge in excess of the above amount.

(3) The construction of a river flushing tunnel and pumping equipment for the purpose of pumping clean lake water into the river above all local pollution, was recommended by two members of the commission.

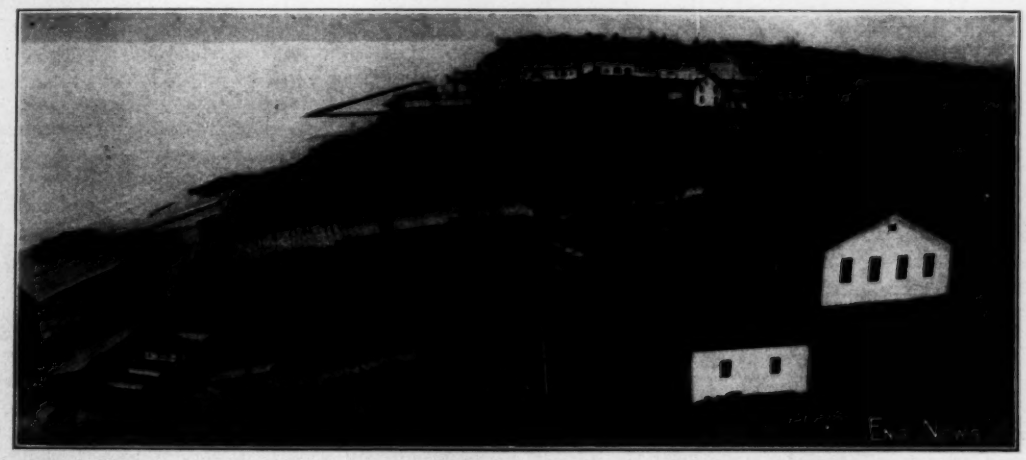

Fig. 1. General View of the Sewage Testing Station, Cleveland, Ohio, from the West

(Taken from the terminal basin tower at end of intercepting sewer. Shows proximity of houses in the background; laboratory building extreme right; screen house right center; grit chamber and tanks in center; filter house and filters at left; corner of Disinfection house extreme left.)

Present Conditions

Since 1896, the recommendations of the commission have in part been carried out and a new water-intake tunnel and crib have been constructed, the entire water-supply now being taken at a distance of four miles from the shore. About one-half of the intercepting sewer system has been completed at a cost of $2,528,575. A main outlet has been established at a point some eight miles east of the Cuyahoga River, it being found impracticable to go further east, without pumping, on account of

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*See Report of D. D. Jackson on Cleveland Water Supply, 1912.

the flat topography. That completed portion of the intercepting system which is tributary to the main outlet serves about 50% of the population and drains the territory in the northeastern part of the city. In addition there is a detached portion of the intercepting sewer which discharges into the lake at West 58th St.

The Main Interceptor is 13½ ft. in diameter and is laid on a grade of 2 ft. to the mile. On the shore of the lake at the terminus of this sewer, there has been constructed a Terminal Basin, which is in effect a combined grit chamber and storm-water overflow. This basin is 100 ft. long and 52 ft. wide. The usual depth of sewage in the basin is 2 ft. at the inlet and 6 ft. at the outlet end. The sewage before entering the Terminal Basin passes through two sets of coarse bar screens, having open spaces of 6 in. and 3½ in., respectively.

The dry-weather flow, and in fact also the wet-weather flow up to about 70,000,000 gal. per day, passes out over a weir 6.67 ft. long and into a 63-in. steel pipe laid below the bottom of the lake and extending 2650 ft. from the shore, where it discharges in about 35 ft. of water.

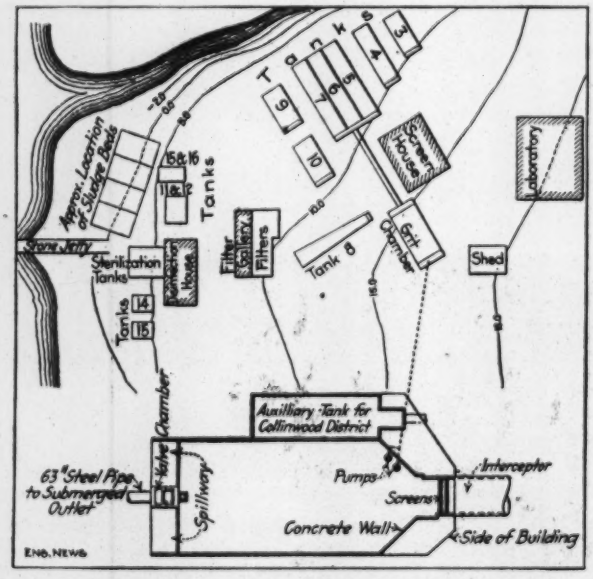


FIG. 2. GENERAL PLAN OF SEWAGE TESTING STATION AND TERMINAL BASIN, CLEVELAND, OHIO

No trouble has ever been occasioned by deposits in the outfall pipe.

The excess sewage during heavy storm flows passes out of the basin over an overflow weir 43 ft. long, onto the beach. The deposits in the tank consist largely of mud and sand and are removed at intervals by means of an electrically operated grab bucket; an unusually heavy flow, however, sometimes washes out these deposits onto the beach.

The Terminal Basin was originally not covered. On account of complaints from near-by neighbors, there has been built over it a steel-frame structure, which includes a tower 60 ft. high, through which the building is ventilated. The tower is placed directly over the screens.

Recent observations as to the quantity of sewage now being discharged at the main outlet, indicate an average dry-weather flow of about 40,000,000 gal., and this is increased three or four times during storms.

Since the discharge of sewage into Lake Erie at this point was begun there has been much complaint in regard to the pollution of bathing beaches and also complaint from summer communities located east of Cleveland, which desire to use the lake for water-supply purposes. The occasional pollution, from this outlet, of the lake water in the vicinity of the Cleveland intake is considered probable.

In connection with the pollution of the lake water at the intake crib, the writer would mention a condition which exists at Cleveland, and doubtless at other lake cities, although he does not wish to be considered as drawing any conclusions in the matter. Hovering around the two principal sewer outlets at Cleveland may be seen at any time large numbers of gulls. These feed on the solid matter in the sewage and splash in the foul water, and they also fly about the lake, sometimes circling around the water-intake crib and diving into the near-by waters. Seeing these gulls at both sewer outlet and water intake, and knowing that it would take but a few minutes to fly from one to the other, one is reminded of the "typhoid fly," which travels between out-house and kitchen. In order to remove the source of attraction for the gulls at the sewer outlet, it is simply necessary to clarify or remove the solid matter from the sewage entering the lake.

The gross nuisance existing in the Cuyahoga River, caused by the discharge into it of the sewage from fifty city sewers and also much manufacturing waste, has been complained of for many years; in fact, there are few if any streams in this country which are more foully contaminated than the Cuyahoga.* It has been quite definitely proven that the polluted water from the river is under certain conditions carried out to the water intake, four miles distant. The discharge of sewage into the lake at West 58th St., within the breakwater, causes severe pollution of the harbor water. To prevent conditions objectionable to sight, smell and comfort, as well as to furnish an additional safeguard to the city's water-supply, it is imperative that the pollution of the Cuyahoga River and of the harbor, cease.

PLANS FOR THE COMPLETION OF THE INTERCEPTING SEWER SYSTEM

In July, 1911, the city council, in order to relieve the gross pollution of the river and harbor, voted $1,000,000 to be used toward the completion of the intercepting-sewer system, in accordance with the original plan of discharging all of the city's sewage, untreated, at the main outlet. In view, however, of protests against the further pollution of the lake, it was decided not to use any of this appropriation until further study had been given to the question of whether any more untreated sewage should be discharged into the lake at the main outfall and also to the question of the feasibility of treatment works.

In January, 1912, the writer submitted a preliminary report relative to the local sewage-disposal problem (see ENG. NEWS, Feb. 8, 1912, for recommendations of report) in which he gave rough estimates of costs of various types of plants and suggested the possible advantage, if treatment works were to be installed, of treating at one or two separate plants the sewage from the portions of the city yet unprovided with main sewers, instead of concen-

*See Report of D. D. Jackson on Cleveland Water Supply, 1912.

trating all of the sewage flow at works on the lake shore near the present outfall, which location is near a high-class residence district. It was also pointed out that economies in sewer construction could be effected by such a plan.

As in any case the magnitude and cost of the treatment works would be great, it was recommended that there be first conducted actual tests of various types of screens, tanks and other devices before adopting a final plan. Accordingly, the city council voted $20,000 for the construction of a sewage-testing station which will be described further on.

Studies made subsequent to the above mentioned preliminary report, relative to the collection and disposal of the sewage now entering the Cuyahoga River, have shown that under the present conditions it is more feasible to depart from the original plan of draining the entire city to one outfall, and to collect the sewage from the southeasterly district (which is not yet provided with an interceptor) and possibly that from the southwesterly district, at a point south of the city limits and in the valley of the Cuyahoga River. A tract of land, covering some 200 acres, adjacent to the property on which is already located the city garbage plant, has been purchased for use as a site for sewage-treatment works. This can be reached without pumping. The sewage treated at this point would be 25 to 40% of the total output of the city, according to whether or not the southwesterly district is included, and would contain, in any case, considerable manufacturing sewage. The sewage from the southwesterly district can be either carried across the river in an inverted siphon to the interceptor leading to the southerly site, or it can be treated at an independent plant at some point on the west side of the river.

It has been decided, in brief, to treat the sewage already discharging through the main outfall, and to establish two other treatment plants, one on the west side of the river and the other south of the city. At these last two plants will be collected the sewage from those portions of the city not connected with the present main interceptor. In other words, little or no new territory will be made tributary to the present main outfall. It is expected that the treatment plant at the main outfall, as well as that on the west side, will comprise means for screening, sedimentation and disinfection only; while at the southerly plant a more thorough method of purification will be needed, at least when the Cuyahoga River is at its low stages.

The pollution of the Cuyahoga River was investigated by the State Board of Health, in June of the present year, with the result that the city was ordered,* after due hearing and with the approval of the Governor and Attorney General, to cease the pollution of the Cuyahoga River before July, 1915, and to install works or means for purifying or otherwise disposing of the sewage now entering said river. The City Council, in accordance with the state order, has already authorized the expenditure of $2,000,000 for this purpose, in addition to the $1,000,000 authorized in July, 1911.

*This order was issued under the Bense Act, so called, which empowers the State Board of Health to compel municipalities to provide for the purification of their sewage, and to issue bonds for this purpose in excess of the debt limit permitted by law for other purposes. See Eng. News, Apr. 9, 1908 (p. 396), for the Bense Act in full, and p. 400 of same issue for editorial comment; for decision of the Ohio State Supreme Court upholding the Act, see Eng. News, July 11, 1912 (p. 45).

The Sewage-testing Station

This station (Figs. 1 and 2) is located on the shore of the lake adjacent to the terminal basin already described, on a seven-acre tract of land owned by the city. The various structures, which are arranged with a view to convenience in operation, cover an area of 200x150 ft. The topography is such that the screens, tanks and filters could be readily placed so that the sewage, after being once pumped into the grit chamber, may flow through these various devices by gravity.

Object of Tests—One of the primary objects of the investigations is to secure a continuous record of the character and amount of sewage now being discharged, not only into the lake through the main outfall, but also into the river and harbor through the numerous sewers not yet intercepted. A general study of the character of the wastes from the principal factories in the city will also be made.

It is intended to install small experimental tanks and filters at the outlets of some of the main sewers in the river district in case it is found that this sewage differs materially in character from that now being discharged at the main outlet. Data thus obtained will be of special value in designing the southerly disposal plant. All analytical work, regardless of the source of the sewage being studied, will be done at the testing-station laboratory.

The main object of the tests and experiments at the main outfall is to determine the most economical method of clarifying the sewage so that it may be discharged into the lake without causing unsightly or objectionable conditions at any point. The clarification tests will comprise studies of various types of screens; plain shallow sedimentation tanks; plain deep sedimentation tanks; vertical flow tanks; two-story tanks; and septic tanks; also roughing or mechanical filters with provision for the settling of the wash water.

There are also to be worked out data relative to the feasibility and expense involved in disinfecting the clarified sewage so that all danger to bathing beaches and water-supplies may be practically eliminated. Data on the electrolytic production of chlorine will also be obtained, as the conditions at Cleveland, where salt is very cheap and where the city makes and sells electricity at a low figure, indicate that this process may prove to be of advantage.

The determination of the method of sludge disposal best suited to local conditions is, of course, one of the most important questions to be solved by the investigation, especially in view of the high-class residence property along the lake front for several miles on both sides of the main outfall. The character of the sludge produced by the various types of tanks will be carefully watched and sludge-drying tests, on sand beds on the shore of the lake, will be conducted. Then a heat dryer will be used to study the feasibility and possible advantages of drying the sludge and changing it into a condition in which it could be stored without offense and disposed of as a fertilizer ingredient in connection with products of the city garbage-reduction plant. Data on the burning and the destructive distillation of sludge will also be obtained.

Pumping Equipment—To raise the sewage out of the main interceptor, for testing purposes, there have been installed a 6-in. and a 5-in. centrifugal pump, the suc-

tions of which are located in the flowing current of sewage a short distance below the coarse screens at the entrance to the terminal basin.

The 6-in. pump is of the vertical type, placed in the sewage and driven by a 15-hp. motor, belted with a ¼-turn belt to the upper end of the extended pump shaft, 12 ft. above the pump. The other pump is of the horizontal type, set upon the same base with and direct-connected to a 30-hp. motor. This excessively large motor is used because the city already owned it. Each pumping outfit is capable of raising 1,000,000 gal. or more per day from the flow level in the terminal basin to the experimental grit chamber, a vertical distance of 15 ft.

About 800,000 gal. of sewage per day will be used for testing purposes, but the amount treated will be varied from hour to hour to correspond to the variation in flow in the main sewer. In other words, it is proposed to treat at all times a fixed percentage of the total flow (up to 2 or 3 times the dry-weather flow) rather than to treat continuously a fixed quantity. This procedure will tend to eliminate inaccuracies in sludge-production data due

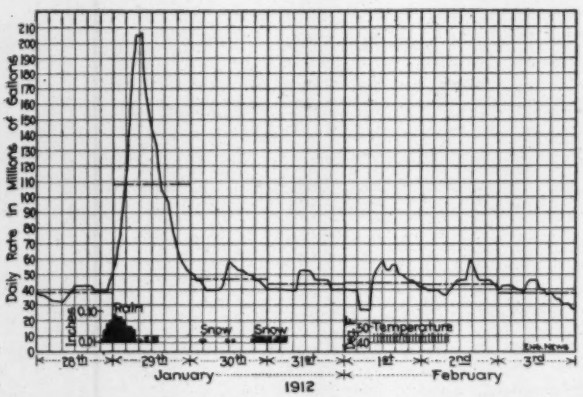


FIG. 3. HOURLY VARIATIONS IN RATE OF SEWAGE FLOW AT MAIN INTERCEPTING SEWER OUTLET, CLEVELAND, OHIO, JAN. 26 TO FEB. 3, INCLUSIVE

to pumping too much weak night sewage and too little strong day sewage.

The average dry-weather flow is about 40,000,000 gal. per day, varying from a 30,000,000-gal. rate to a 50,000,000-gal. rate (see chart, Fig. 3), and it is intended to treat 1½% of this at all times. The speed of the motor and pump being constant, the hourly variations in rate of pumpage are obtained by opening or closing a relief valve located in the force main just above the pump, which valve allows the surplus sewage to fall back into the terminal basin. The attendant will, therefore, read, each hour, a gage indicating the flow in the main sewer (measured at the outfall weir of the terminal basin) and then turn the relief valve the requisite number of times to secure a pumpage of 1½%. Of course, during heavy storm flows reaching a 200,000,000-gal. rate the same proportion cannot be treated.

GRIT CHAMBER—The grit chamber into which the sewage first enters is divided longitudinally into two parts, each of which is 5x25 ft. in plan, by 3 ft. deep at the upper end and 5 ft. at the lower end. The intention was to operate, at first, at a velocity of from 6 to 12 ft. per min. Since starting the tests it has been found that this velocity is too slow to prevent the deposition of objectionable organic matter. The grit chambers have therefore been remodeled and the velocity increased to about 30 ft. per min. The grit chamber will be used only at times of storm flow and will be by-passed ordinarily. A smaller grit chamber will be built for the dry-weather flow if this should prove desirable.

DISTRIBUTING FLUME—This adjoins the lower end of the grit chamber and conveys the sewage to all of the tanks. The main flume, extending across the upper ends of Tanks 5, 6 and 7, together with the entrance channels built on to the upper ends of the remaining tanks, constitute a reservoir from which the sewage is drawn off through measuring weirs of different sizes, into the tanks themselves. The supply for the screen house is taken from the flume just below the grit chamber. The respective crests of all the weirs are set level, although the weirs are of various lengths. By this arrangement the rate of flow through each tank always bears the correct proportion to the total pumpage, which will be varied from hour to hour as above discussed.

PLAIN SEDIMENTATION TANKS—Tanks 3, 4, 7 and 8 are classed as sedimentation tanks. Nos. 3 and 4 are 25 and 15 ft. deep, respectively, the former being 7x20 ft. in plan, the latter 7x30 ft. (see Fig. 4 for details of Tank 3). They will receive about 100,000 gal. of sewage per day, representing about a 4-hour storage period. Both tanks have hopper bottoms, 7x10 ft. in plan, and separate sludge drains extending to the bottom of each hopper. The intention is to draw off the sludge regularly without draining the tanks. Tanks 3 and 4 will later be changed to vertical-flow tanks, the sewage to be discharged near the bottom and drawn off at the top, as in the Dortmund type of tank.

Tanks 7 and 8 are also of the hopper-bottom type, but shallower. They also will be operated on a 4-hour storage period. Tank 7 is 8x40 ft. in plan and 8 ft. deep to the bottom of the hoppers. Tank 8 is 40 ft. long and of unusual design (see lower part of Fig. 5). It is 4 ft. wide at the inlet end and 8 ft. wide at the outlet end. The bottom is formed into three hoppers, which are, respectively, 10 ft., 9 ft. and 8 ft. deep below the flow line. The tank was designed with the thought that the heavier solids would settle out first, and that the volume of sludge so deposited would be relatively greatest in amount at the influent end, hence the deeper space at the upper end. The lighter particles, which will be deposited later, under decreasing velocity of flow, will drop into the shallower portion of the tank.

SEPTIC TANKS—Tanks 5 and 6 are each 40x8 ft. in plan, with a flat or single-plane bottom, 8 ft. deep at the upper end and 9 ft. deep at the lower end. These tanks, while classed as septic tanks, will doubtless later be operated as plain sedimentation tanks on the basis of a 6- to 8-hour storage period.

TWO-STORY OR EMSCHER (IMHOFF) TANKS—Tanks 9 and 10 are of the straight-flow Imhoff type, each 10x20 ft. in plan, 25 ft. and 20 ft. deep, respectively (see Fig. 5). The inner flow channels are 20x7 ft., and are approximately 12 ft. and 8 ft. deep, respectively, representing a 3½-hr. and a 2½-hr. storage period when treating the proposed average quantity of 100,000 gal. per day.

DILUTION TANKS, AUXILIARY SETTLING TANKS AND SLUDGE DIGESTION TANKS—There are two dilution tanks, each 8x10 ft. by 6 ft. deep, for studying the pro-

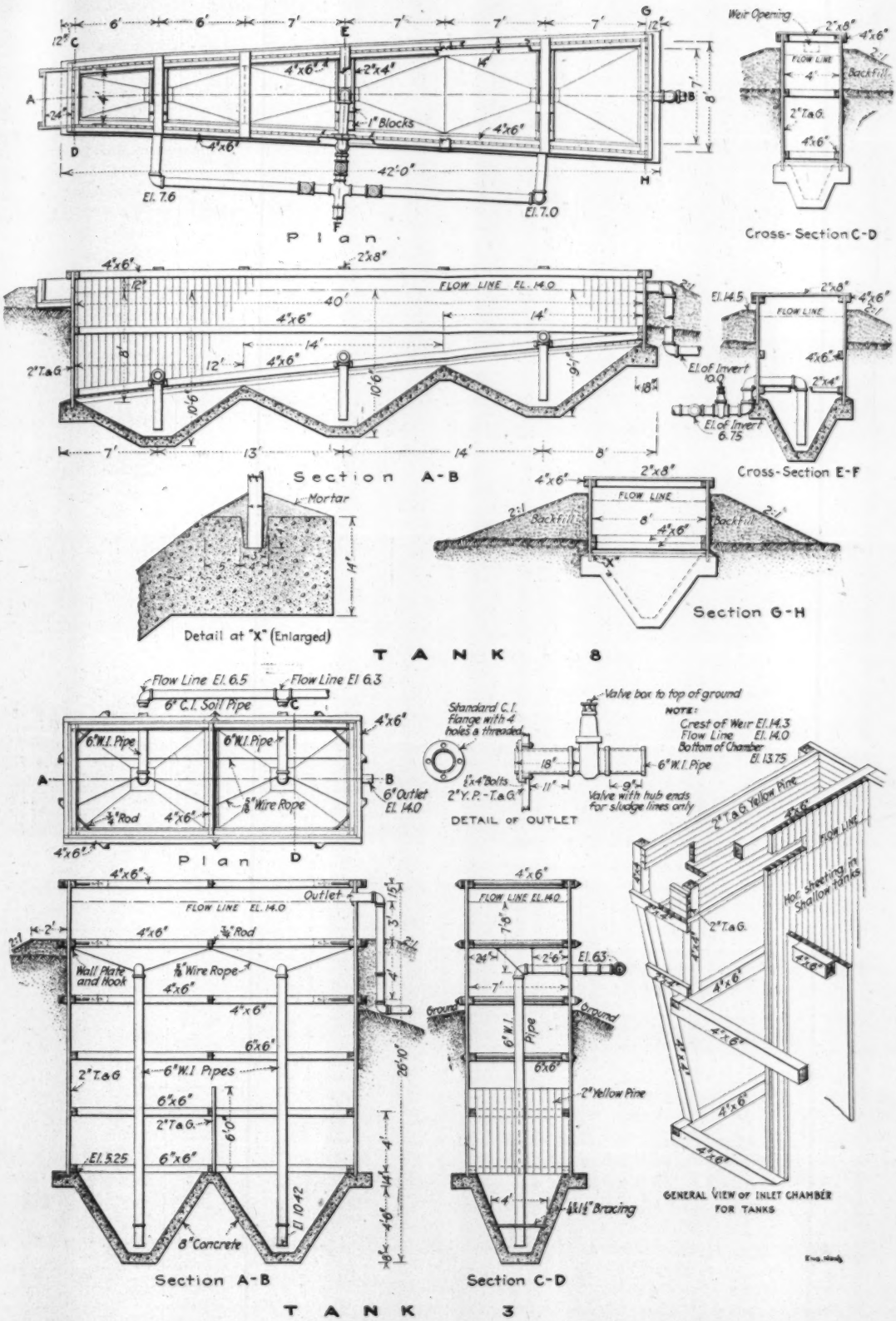
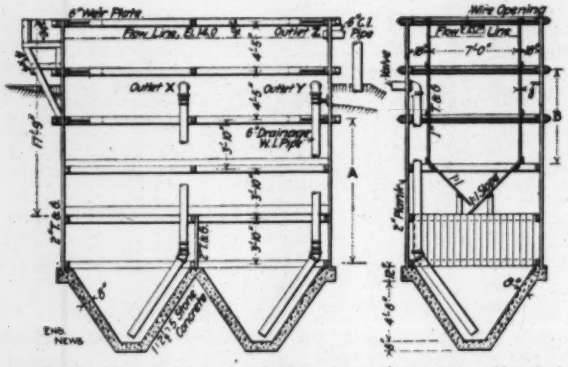


FIG. 4. PLAIN SEDIMENTATION TANKS 3 AND 8, CLEVELAND SEWAGE TESTING STATION

(Baffles for Tank 3 omitted.)



(Tanks 9 and 10 are of this general design. No. 9 is 15-25 ft. deep and No. 10 is 15-20 ft. deep. Dimensions of each are the same, except A and B.)

Tank 9:		Tank 10:	
A = 11 ft. 6 in.		A = 6 ft. 6 in.	
B = 8 ft. 3 in.		B = 5 ft. 9 in.	
Elev. bottom	— 11 ft.	Elev. bottom	— 6.0 ft.
Elev. outlet X	+ 4.9 ft.	Elev. outlet X	+ 5.5 ft.
Elev. outlet Y	+ 4.7 ft.	Elev. outlet Y	+ 5.3 ft.
Elev. outlet Z	+ 14.0 ft.	Elev. outlet Z	+ 14.0 ft.

FIG. 5. EMSCHER OR IMHOFF TANKS, CLEVELAND SEWAGE TESTING STATION. (BAFFLES OMITTED)

portion of clean water necessary to inoffensively dilute the effluents from the several clarification processes. There are two auxiliary settling tanks, each 7x10 ft. by 15 ft., for clarifying the wash water from the mechanical filters or scrubbers and for settling the effluent from the sprinkling filter. The two sludge digestion tanks, each 7x7 ft. by 16 ft., are for digesting or decomposing the sludge from the several plain sedimentation tanks in order to enable a comparison to be made between sludge so treated and sludge from the two-story tanks.

GENERAL CONSTRUCTION OF TANKS—The tanks being for temporary use only are, with the exception of the grit chamber, constructed of 2-in. Norway pine tongued-and-grooved lumber, fastened to yellow pine 6x6-in. and 8x8-in. framing. Tanks 5, 6 and 7 have wooden bottoms, while all others have concrete bottoms. The deep tanks are mostly in clay soil, which tends to make them water-tight. Tanks 3, 4 and 9, however, being located quite near to the creek bank, required a special waterproofing of from 4- to 8-ply tar paper and pitch. Some difficulty was also found in making the wooden-bottomed tanks tight. The grit chamber, made of square-edge 3-in. lumber, with 3-in. steel rods about 2 ft. c. to c. running vertically through it, gave no trouble.

The piping within the various tanks and also the lines which connect them to the filter and disinfection devices are cast-iron soil pipe, this being at the time of purchase much cheaper than wrought-iron pipe or cast-iron water pipe. The valves are all lightweight gate valves, made by Crane & Co., and are cheaper than ordinary water-gate valves.

Baffles were not placed on all the tanks during construction, the idea being to add baffles wherever they were found to be desirable. Since the plant was put in operation all tanks have been provided with two or three baffles each.

SCREENS AND SCREEN HOUSE—Tests are to be made on the efficiency of fine screens of various meshes. There are to be four screen boxes, each 2½x5 ft., with grooves for insetting different screens. About 25,000 gal. per day will be handled in each screen box. The screened sewage flows to Tanks 5 and 7, or it can be diverted directly to the disinfection house. A centrifugal machine has been provided for drying the screenings.

The screening devices are located in a 24x30-ft. wooden building, in which is also placed the boiler which heats the laboratory.

FILTER AND FILTER HOUSE—There have been installed one sprinkling filter and three rapid filters on scrubbers (see Fig. 6 for section). The sprinkling filter is a wooden box 12 ft. square, containing 6 ft. of slag. The sewage from one of the sedimentation tanks will be applied through one nozzle, located in the center. This filter will be dosed intermittently from a wooden dosing tank operated by 3-in. Miller siphon and located on the roof of the filter house.

The station was put in partial operation on Dec. 1, 1912, but the work was not established on a routine basis

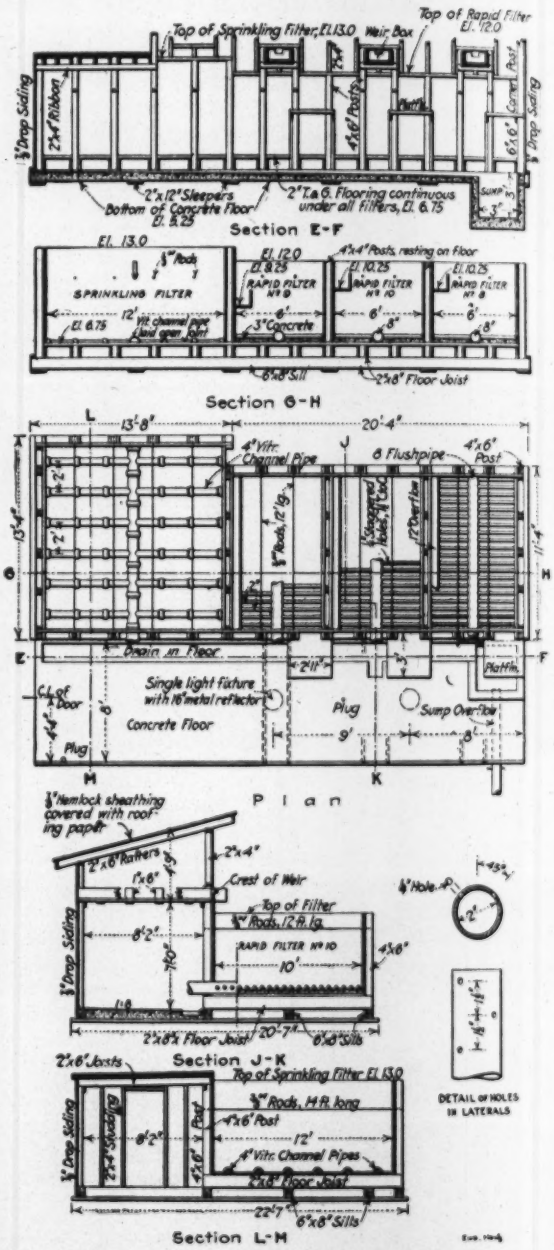


FIG. 6. SPRINKLING AND RAPID OR SCRUBBING FILTERS, CLEVELAND SEWAGE TESTING STATION

until about Jan. 1, 1913. It was expected (Jan. 27) that the disinfection work would be started by Feb. 1, 1913.

The rapid filters are made of watertight wooden boxes, each 10x6 ft. in plan and provided with such piping and fittings as are necessary to form a mechanical water filter. Two of the rapid filters will contain 3 ft. of fine gravel filtering material and the third will contain 2 ft. of material. The filters will be back-washed by water from the city main. The dirty wash water from the rapid filters will pass into a deep settling tank the effluent from which will be disinfected.

Along one side of the filter has been built the filter house in which are located the valves necessary for operating the filters. Here also is a hydraulic ram, placed on the effluent line from the sedimentation tank. This ram automatically raises the requisite amount of sewage into the dosing tank which supplies the sprinkling filter, thus saving repumping of this amount.

Disinfection House—This is a two-story, 16x32-ft., wooden structure, and contains all the devices for mixing

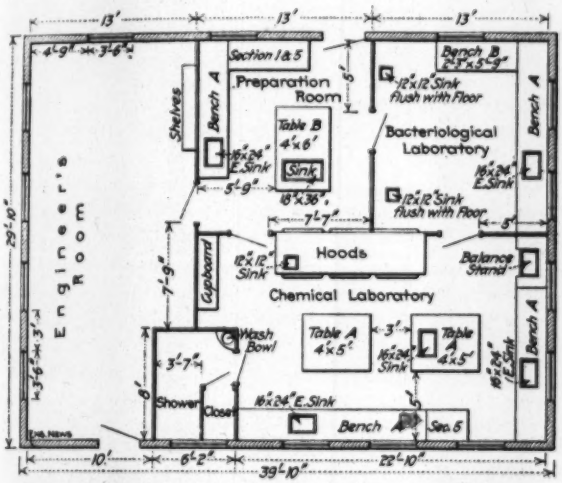


Fig. 7. Plan of Laboratory, Cleveland Sewage Testing Station

and applying disinfectant to the various tank effluents. On the lower floor are three chemical storage tanks; one of galvanized iron (to be painted with enamel paint), 8 ft. in diameter and 10 ft. deep; one of wood, 8 ft. in diameter and 10 ft. deep, and one of concrete, 4 ft. square in plan and 5½ ft. deep. The first two tanks are to be used for the storage of calcium hypochlorite, while the concrete tank will be filled with sodium hypochlorite. The three different materials, galvanized iron, wood and concrete were used in order to note the relative effect of the chlorine on them. On the lower floor is placed a large feed box or constant-level tank, which can be fed from either of the circular tanks. This box has six outlets, each with its adjustable orifice.

On the upper floor will be stored the calcium chloride, which will be introduced into the tanks from here. There is also a brine tank in which will be mixed the salt solution to feed the electrolytic cell which is to make the sodium hypochlorite. The cell is known as the "Dayton Cell," and will be placed immediately over the concrete tank.

Passing under the floor of the disinfection house and also under the orifice box are six 6-in. pipe lines leading from five tanks and from one filter. The sewage passing through each line will be treated with the disinfectant solution and then passed into a reaction tank, of which there are six, located just outside of the disinfection house. The tanks are each designed to hold about 20 minutes' flow of sewage and are highly baffled so as to insure a rapid (up and down) flow through the tank.

Sludge Treatment—There are four sand-sludge beds, each 10x20 ft. by 2½ ft. deep, placed at such elevation that the sludge from any tank can flow onto them. Each bed comprises an open wooden box filled with 20 in. of lake sand.

As mentioned above, it is proposed to study the drying of sludge in a direct heat dryer, either before or after partially drying it by some other process. The dryer will be constructed in accordance with designs made by W. J. Springborn, Director of Public Service of Cleveland, who has had extensive experience in the construction and operation of garbage-reduction and drying machinery. If it should be found that it is feasible to dry the sludge in this way, the dried material could probably be sold by the city for fertilizer base in connection with the products of the municipal garbage-reduction plant. No expectations are entertained, of course, of placing such a method on a money-making basis; but, as such a method would afford a sanitary means of disposing of sludge, especially where little land is available, it is desired to obtain figures on the net cost involved in handling the sludge in this way. It is expected to devote considerable time to making chemical analyses of the various sludges.

Some studies will be made of the burning and distillation of dried sludge and data on its fuel value will be obtained. The digestion or septic decomposition, in separate sludge tanks, of sludge drawn from some of the plain sedimentation tanks will be investigated by means of the sludge-digestion tanks above mentioned.

Laboratory—The laboratory building is a one-story, 30x40-ft. structure. It is divided (Fig. 7) into an engineer's office, chemical laboratory, bacteriological laboratory and preparation room. A very complete equipment has been provided as regards analytical apparatus, and this has been chosen with particular reference to making sludge analyses and disinfection studies, as well as standard analyses of sewage and effluents. The rooms are well supplied with water taps, gas cocks, sinks and drains. There is also a shower bath and a water closet. A large-sized hood, accessible from both laboratory rooms, has been installed. The building is well heated by steam generated in the boiler located in the screen house.

Proposed Schedule of Operation—The accompanying chart (Fig. 8) indicates in a brief and condensed manner the schedule which it is proposed to follow at the start (full lines) and also the systems which will probably be followed later (dotted lines). It is expected that various new problems will arise during the course of the tests and the necessary changes of schedule will be made to enable these problems to be taken up if they are considered of sufficient importance. The septic tanks have been installed chiefly to furnish comparative results and these will doubtless be operated as plain sedimentation tanks or used for other purposes later. The sprinkling filter, also, is to be operated in order to afford comparison between its efficiency, under the local conditions, and the efficiency of some of the other devices, rather than

with the expectation of adopting the sprinkling filter in the design of the permanent plant.

Modifications of the forms and dimensions of the various tanks will suggest themselves as the tests proceed. For example, it is probable that a shallower and less expensive form of Emscher (Imhoff) tank from which the sludge can be removed by compressed air (with the idea of obtaining a porous sludge) would be worthy of study.

PERSONNEL—The testing station is under the general direction of the Department of Public Service, of which W. J. Springborn is director, and Robert Hoffmann, chief engineer. The writer is engineer-in-charge of the station; H. B. Hommon is chief chemist and bacteriologist; G. B. Gascoigne, assistant chemist; E. G. Dyer, assistant

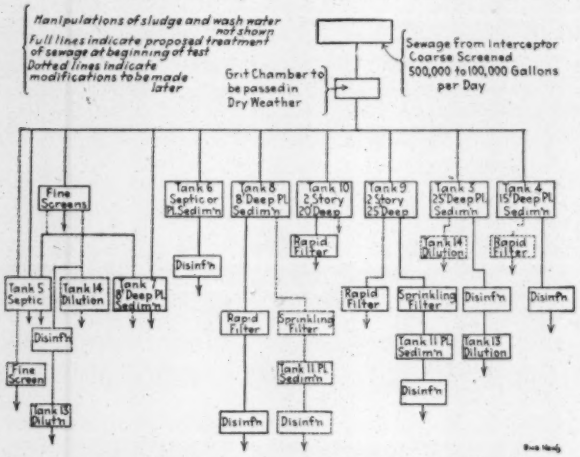

Manipulations of sludge and wash water not shown
Full lines indicate proposed treatment of sewage at beginning of test
Dotted lines indicate modifications to be made later
Grit Chamber to be passed in Dry Weather
Sewage from Interceptor Coarse Screened 500,000 to 100,000 Gallons per Day
Fine Screens
Tank 6 Septic or Pt. Sedim'n
Tank 8 8' Deep Pt. Sedim'n
Tank 10 2 Story 20' Deep
Tank 9 2 Story 25' Deep
Tank 3 25' Deep Pt. Sedim'n
Tank 4 15' Deep Pt. Sedim'n
Rapid Filter
Tank 14 Dilution
Disinf'n
Tank 5 Septic
Tank 14 Dilution
Tank 7 8' Deep Pt. Sedim'n
Rapid Filter
Sprinkling Filter
Tank 11 Pt. Sedim'n
Tank 13 Dilution
Fine Screen
Tank 13 Dil'n

FIG. 8. GENERAL SCHEDULE OF OPERATIONS, CLEVELAND SEWAGE TESTING STATION

bacteriologist, and A. C. Lucas, assistant engineer. There are also a janitor for the laboratory and four attendants, whose duties are to collect samples and make flow observations. One attendant is on duty at all times.

⁂

Burned-clay Ballast for Electric Railways is suggested in connection with the construction of such lines in the province of Alberta, Canada. Gravel and sand are scarce and of high price in the district to be served, but as the subsoil is mainly clay it has been suggested that this might be burned for use as ballast. Such material has been used in the Western States by a number of steam railways, and there seems to be no reason why it should not be satisfactory on electric lines, provided that the clay is of suitable character, although we have no information as to its previous use on such lines. Perhaps some of our readers can refer to electric interurban railways, which have used this ballasting material and can give us some information regarding the methods, cost and results.

⁂

Canadian Railway Construction in 1911-12—During the year ending June 30, 1912, there were 2953 additional miles of railway put into operation in Canada, 1738 miles more were reported as ready for operation, and about 10,000 miles were under construction. The total railway mileage of Canada, exclusive sidings and double tracking, is given by the Railways and Canals Department as approximately 30,000 miles, representing a total investment in stocks and bonds (exclusive of government lines) of $1,588,937,526, an average of $50,832 per mile. Dividends were paid equaling 4.04% of the total stock issue. The public has aided the construction of these railways to the extent that the total sum contributed in cash by the various federal, provincial and municipal authorities amounts to over $208,000,000, while land grants of 56,000,000 acres have been acquired by the railways. Railway bonds have been guaranteed by federal and provincial governments to the extent of $245,070,045. The number of railway employees was 155,901.

The Design of Hot Water Supply Systems to Minimize Corrosion

BY F. N. SPELLER*

In a paper on the "Durability of Welded Steel Pipe,"[1] reprinted and commented upon in ENGINEERING NEWS, Mar. 23, 1911, there was discussed the results of investigations on the relative corrosion of iron and steel in service, and the influence of the dissolved gases (oxygen and carbonic acid) in water and a scheme was suggested for rendering the water practically harmless by removing the air after heating. So far as the writer is aware, however, no system has yet been designed with this as the main object.

In the paper referred to, the writer pointed out, first, that the superiority claimed for "genuine" wrought-iron pipe had not been proven by comparative tests in service; on the contrary, the numerous cases which are on record (and which have been largely added to since that time), show conclusively that where both iron and steel have been used together in water lines, the wrought-iron pits just as badly as the steel under the same conditions. A number of such comparisons were compiled by the writer for the International Congress for Testing Materials last September.[2]

We need not again go into the cause of this pitting, which is now generally recognized to be due to galvanic action between impurities on the surface of the metal, especially mill scale and rust. The leading authorities now seem agreed that corrosion is practically independent of the composition of the metal, provided it is reasonably uniform (as the steel used for welded pipe must necessarily be if it welds without developing injurious defects).

In order to have continued corrosion, oxygen must be present in solution; the removal of this oxygen has been found to greatly lessen corrosion. In his recent report of researches along this line, Dr. W. H. Walker, Director of the Research Laboratory of the Massachusetts Institute of Technology, describes one of his experiments thus:[3]

> Two coils made up from pieces taken from the same length of pipe were each fed with water from the same source at the same temperature. In one case the water was heated to 85° C. in an open tank, while in the other the water was heated to the same temperature in a closed tank. The feed water contained on the average 5.85 c.c. of oxygen per liter, and passed through each coil at the rate of ½ gal. per min. After running 1750 hr., the coil fed with water heated in an open tank had lost 22 grams, while the soil fed with water heated in a closed tank had lost 155 grams. In neither case was the oxygen completely removed; if the water in the open tank had been gently boiled, corrosion in the coil fed with this water would have been completely prevented.

These results again indicate that the intensity of conditions have much more to do with corrosion than anything else; so much so that the same material used as a pipe in a hot-water heating system, where the water is practically free from oxygen and unchanged, should last 50 years or more, while in a closed hot-water supply system it may only last five or six years.

*Metallurgical Engineer, National Tube Co., Frick Bldg., Pittsburgh, Penn.

[1] "Proceedings, American Society of Heating and Ventilating Engineers, 1911.

[2] "Comparative Service Obtained with Wrought Iron and Soft Steel Pipes as Water Lines in the United States," Proc. International Association for Testing Materials, 1912, XXIV, 4.

[3] "Engineering News," Dec. 21, 1911; "Journal of New England Water Works Association," March, 1912; "Journal of Industrial and Engineering Chemistry," July, 1912.

This principle of heating and freeing the water from dissolved oxygen, by which it seems possible to prolong the life of standard welded pipe several times, is surely worthy of careful consideration in designing piping systems which are subject to corrosion.

A recent investigation, undertaken by the writer with the assistance of some of his research staff, has developed interesting points in regard to the present practice of laying out hot-water supply systems. The influence of the arrangement of the piping on corrosion seems to be quite marked, depending on whether the gases are liberated before the water enters the distributing system or not, although the separation of these gases is only partially accomplished under the best conditions. Large installations were considered, such as hotels, large apartments and office buildings where, on account of the great quantity of hot water used, serious trouble would be most likely to occur.

The hot-water supply systems found in these buildings differ in many details, but may be divided into two classes, according to whether the main vertical distributing lines are supplied from a common horizontal main in the basement, or from a similar horizontal distributing main above the level of the highest fixture near the roof. These types of installations are illustrated, diagrammatically and without detail of any kind, in Figs. 1 and 2.

The underfed system is characterized by a number of independent risers and return-risers, each supplying a separate section of the building. These risers are rarely vented at the top and consequently the hot water is always supersaturated with air when the system is in continuous use. This is a good example of the closed type of heating so designed that it would be very difficult, if not entirely impracticable, to vent so as to remove the gases before the water is used.

The system illustrated by Fig. 2, on the other hand, is radically different in this respect and to a considerable extent, although not completely, allows the escape of dissolved gases to the atmosphere at the highest point before the water is distributed throughout the system and returns to the heater. Since all the water used passes up through one riser a vent must be provided, otherwise trouble due to the trapping of air in the upper lines would probably be experienced. It would seem to be a very simple matter to almost completely free the water from dissolved gases with such a system, by putting a simple air-separating device at the upper end of the main riser, as indicated at the point *A* in Fig. 2. To obtain the best results, the water should be heated to about 200° F., using an inter-cooler, if desired, to reduce the temperature after leaving the air-separating chamber.

The writer has discussed only general principles affecting the life of the piping system; the details necessary to carry out these principles in practice will, of course, require thought and expert knowledge of design on the part of practical engineers having to do with heating and plumbing.

With pure water, such as is supplied to New York City for example, the percentage of dissolved gases is proportionately high, so that the benefit to be expected from such treatment when thoroughly carried out and maintained would probably be very marked.

Several cases investigated, where large systems of hot-water supply lines have suffered serious damage in six or eight years, have all occurred in buildings equipped with closed heating systems. So far, we have not found serious trouble in systems of the open type where any attention has been given to venting, although the significance of adequate venting of such systems does not seem to be appreciated by architects and engineers, for in some cases, where vents were provided, the practice was to keep them closed except when trouble with air-hammer was experienced.

Engineers and architects have perhaps hesitated to make changes in the closed system of heating without more practical evidence of a substantial character, the scientific study of corrosion being all new ground. The writer hopes to see a free discussion, on the part of those who have most experience in such work, so that the best system of design may be developed for such installations with due regard to prevention of corrosion.

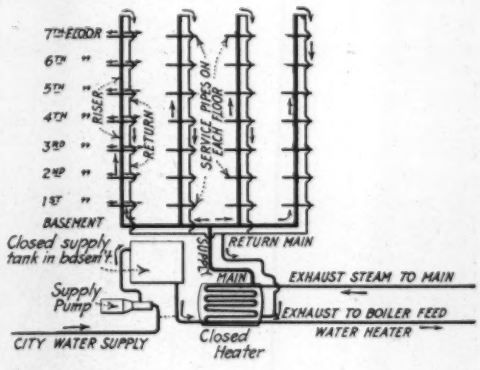


FIG. 1. UNDERFED CLOSED SYSTEM

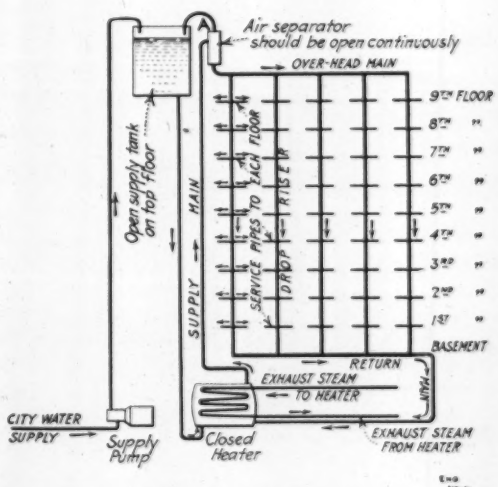


FIG. 2. OVERHEAD OPEN SYSTEM

FIGS. 1 AND 2. TWO TYPES OF HOT-WATER SUPPLY SYSTEMS

The Hughes Terminal on the Delaware River at Philadelphia

By H. McL. Harding*

Delaware River Traffic—The Delaware River, on which this new terminal is to be located, carries more commerce than any other river in the United States. In 1910 the freight was 25,496,000 tons, having a value of $1,340,392,000. This commerce pays into the United States treasury approximately $20,000,000 annually. In 1911 the port of Philadelphia made a new commercial record—a greater number of vessels and a larger tonnage

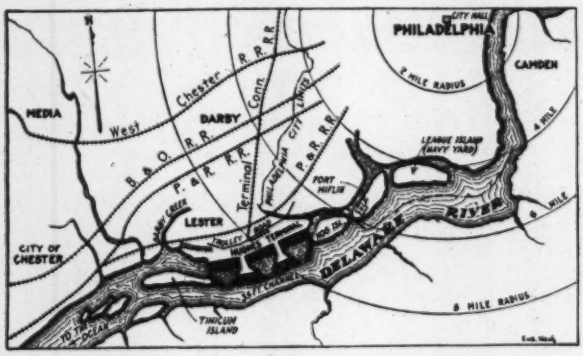


Fig. 1. Map of the Port of Philadelphia, Showing the Proposed Hughes Terminal

than in any previous year. The principal shipbuilding interests of the country are on the Delaware River.

In Philadelphia there is now little unoccupied space out of the 56,640 lin.ft. of water front. There is no effective coördination here between the rail and water lines, and this is especially true of the transshipment and transfer sheds, the warehouses and the industrial sections. The total volume of traffic handled at Philadelphia in the year 1911 by the three railways entering amounted to 32,562,000 tons; all the railway terminals are more or less congested.

Location of the Proposed Hughes Terminal—By an inspection of Fig. 1, the position of the Hughes Terminal in relation to the city of Philadelphia and the surrounding country is clearly indicated. It is contiguous to the boundary line of Philadelphia, and about eight miles from the City Hall; it is directly on the Delaware River, about 80 miles from the sea, and has an advantageous situation. The projected terminal is 105 miles nearer Panama than New York. It is nearer the great manufacturing centers of Philadelphia, Pittsburgh and Chicago than any other Eastern seaport terminal. There will be small taxes, and control of the township will rest with the terminal authorities.

Including the three adjoining counties and the smaller cities, there is a contributing population near-by of not less than 2,500,000; but the shippers and consignees in a greater population of many millions will use this terminal if the facilities are favorable, for contributing to this terminal will then be the rich states of Pennsylvania, Ohio, western New York, Indiana, Illinois and others.

The physical characteristics of the location show Tinicum Island, a low-lying stretch of land, and on a line between that and Hog Island (Fig. 1) another island, then very shallow water or a submerged b[illegible] and the Miflin Bar Dike of the government which c[illegible] off the shallow water between the island and the ma[illegible]land and the Delaware River.

The shallow body of water to the rear of th[illegible] islands and bars averages 7 ft. mean low water and is called the Miflin Basin. It is mostly owned by the termi[illegible]. From the channel now being dredged by the gover[illegible]ent, and from the deepening of the center of the basin (Fig. 2) there will be material for the earthfilling of the initial development.

Acreage and Frontage—This new terminal will contain, south of the trolley road, about 2500 acres. This includes the shore land, the Miflin Basin, the islands in front, the whole of Tinicum Island and the submerged lands which are part of the Tinicum Island property. There will also be about 500 acres north of the trolley road.

In the first layout, as planned, there will be about 25,000 ft. of lineal frontage, or berthing capacity at one time for some 40 vessels 500 ft. long. There will be two piers, each 1000 ft. long. There is space for eight 1000-ft. piers within the basin. In future developments, each new basin will have practically the same lineal pier and quay length, the three basins would therefore have a lineal frontage of 60,000 ft.

There can be five river piers, with 10,000 ft. frontage, in front of the cotton area. Other river piers can give 24,000 ft. additional. Furthermore there can be developed a frontage upon both sides of Tinicum Island

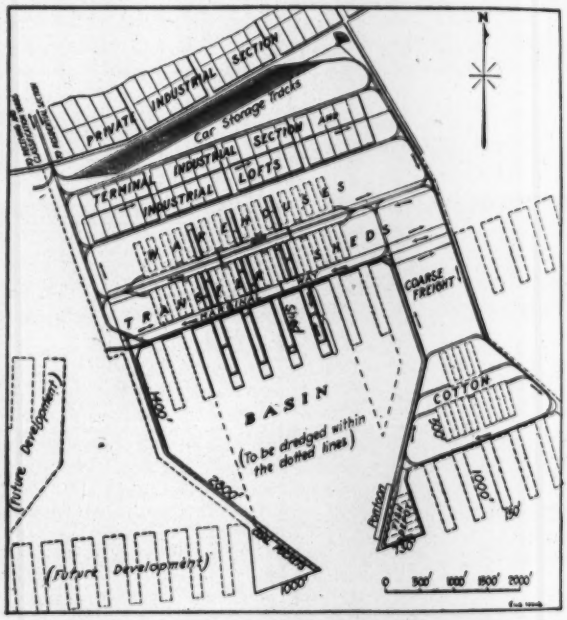


Fig. 2. Plan of Development; Hughes Terminal, Philadelphia

west of the terminal development proper. It will therefore be seen that there will be a surplus of frontage for many years to come.

It is estimated conservatively, by making use of the latest mechanical appliances, there should be an annual transferring capacity at the 20,000 lin.ft. of pier and quay walls of about four million tons.

The Waterway—There is at present a depth of 30

*Consulting Engineer, Department of Docks and Ferries of the City of New York, 17 Battery Pl., New York City.

ft. in the channel, and appropriation has been made by the government to increase this to 35 ft., with a width of 800 to 1000 ft.

The river here is a mile and a quarter wide. There is water area for all terminal requirements, including anchorage and ship-turning space.

Railway Facilities—It is the intention to provide ample room in this terminal for trackage for all purposes, including team-track facilities, sidings and storage yards, receiving and classification yards, and perhaps a transfer station. In its final development there will be 60 miles of trackage. It is the purpose to transfer the freight, as far as practicable, directly to cars upon tracks behind each pier or quay. This may be from the ship's hold, from the deck, or from the pier side. Proper consideration will be given in this connection to customs regulations, assorting and distributing. In order to do this without rehandling, which would add some 15 to 20c. per ton to the cost of transference of miscellaneous freight, it is necessary to have placement for at least 300 cars in each one or two combined sections of the terminal. In the storage yards, to the north of the terminal, will be trackage for over 900 additional cars, and more trackage in other locations. Trackage is also provided for cars within and between the sheds and warehouses and between the warehouses and the industrial section. Space can readily be reserved still further to the north of and within the terminal grounds for classification and transfer yards.

Between each of the four lines of tracks serving the piers and quays are platforms, about 20 ft. wide. This enables the cars to be loaded or unloaded without "spotting." Many sidings will be so arranged, not only for local freight, but also for full carloads, and for the local team freight.

No successful terminal has proved to be too large, and all the available space here will sooner or later be urgently needed. It therefore seemed advisable for the tracks to pass through the lower story of the sheds. Another advantage of this is that the handling and transferring of the freight is done under cover, avoiding horizontal movements; the work can proceed during inclement weather, and the property be protected from damage and also from theft.

It is also proposed to extend the sidings through a portion of the lower story of the warehouses for similar reasons, and for the direct elevation of freight to the upper stories, but tracks are not to be extended within the pier-sheds or upon the piers, except possibly on special piers for the transference of bulk freight or cargoes of few marks. For miscellaneous or package freight service, it is not advisable that cars should pass upon the piers.

The railway franchises of the terminal, extending to the rear of the terminal lands and connecting with independent railroads, will serve all parts of the terminal and may be supplemented by overhead transfer tracks.

Internal Water Area—The basin will be an anchorage place for barges and lighters, and a temporary mooring place for even the longer vessels.

One slip has been indicated as dredged within the eastern portion of the basin, about 2600 ft. long and 300 ft. wide. The reason for this is that it seems to be excellently well adapted for special freight and for transference to the local industries by railway or transfer tracks.

As there must be a location where certain classes of cargoes can be transferred directly between ships and lighters, the basin can be used for this purpose.

Marginal Way—A strip of land 200 ft. in width, in front of the transfer sheds and called the marginal way, is reserved for the common use of all the factories and the whole terminal, and for surface tracks and overhead runways.

Transshipment Sheds—These sheds in the basin section are upon the piers. Only two sheds will be constructed at first. These will be of one story, about 40 ft. high, 138 ft. wide and 800 ft. long, fully equipped with freight tiering and transferring machinery.

To the east of the basin will be other transit sheds in the future, 100 ft. wide and 500 ft. long, of the two-section type. These are chiefly for the transference and storage of cotton and similar material which, on account of fire risk, it is desirable to isolate.

Locations for some special commodities are shown on Fig. 2, but provisions have been made for other commodities such as tobacco, wool, ore, phosphates, lumber, fruit and for markets. Lumber and structural-steel yards will later be located west of the basin. There might well be storage warehouses for perishable freight and a market.

Transfer Sheds—To the rear of the marginal way are transfer sheds for transference to and from cars or drays, and for shorter-time storage than in warehouses. There are five groups of these sheds, with five sheds in each group, each shed being 500 ft. long and 100 ft. wide. Only four sheds will be erected and equipped in the beginning. These are one story in height, with elevated or auxiliary floors. The lower section is 14 ft. high and the upper section is 26 ft.

Warehouses—Toward the north of the transfer sheds, between them and the industrial section, will be located warehouses, of which only two need be constructed at first. They will be of reinforced concrete and will have sprinklers for fire protection. Each warehouse is 500 ft. long and 100 ft. wide, with a connecting wing, with fire walls and doors between wings. The walls will be designed for sufficient strength to sustain other stories. The lower section of these will be reserved for car tracks, car platforms and dray platforms. Above the car platforms will be openings so that freight can be taken to the upper floors.

Machinery—Later devices consist in overhead trackage and electric transferring and hoisting machinery. This conveying mechanism consists of a transfer-tractor which draws after itself from one to four trailers, each trailer supporting an electric hoist. This transfer-tractor constitutes the traveling-conveying mechanism, having a speed up to nine miles an hour, with its complement of trailers and six tons of freight.

Power House—A 1000-hp. central station will be located on the west side of the basin for supplying light and power. The lighting generators will furnish alternating current; there will be two 500-volt direct-current machines for power.

Use of the Terminal—The piers, pier-sheds and marginal way will be for the common use of the terminal. Certain transfer sheds will be rented exclusively to transportation companies rather than the piers or pier-sheds, and the terminal company will transfer freight between the vessel or the pier and the transfer shed; it can do it

at a less cost than the transportation company can handle it upon a pier alone.

COST AND INCOME—The initial investment expenditure would be about $2,900,000. The estimated gross income will be about $1,200,000, the expenses $580,000, and the net income $660,000.

Recommended Changes in Portland Cement Specifications

The Bureau of Science of the Philippine Islands has been investigating for five years the physical and chemical properties of portland cement and has published the results from time to time in the *Philippine Journal of Science.** These studies have recently been brought to an end and the final results published in the June, 1912, issue of the *Philippine Journal of Science.* While pressure of space forbids any complete résumé of the entire publication of these studies or even of the summary of them, which appears in the last report noted above, the final conclusions as to possible reform in cement specifications are interesting as indicating the general conclusions of the investigators, and they are given below. The complete report of the work can be obtained from the Bureau of Science, Manila, P. I. The studies were under the general direction of W. C. Reibling, Chief, Division of General Inorganic and Physical Chemistry.

The conclusions follow:

(1) The qualities in portland cement which we need are constancy in volume and setting properties, and reliability of strength, and it is of vital importance that this material both harden rapidly and maintain great strength. We believe that the enforcement of the following recommendations will increase the efficiency of the present standard cement specifications of the American Society for Testing Materials.

A. Concerning the constancy of volume:
   (a) In order to secure the desired efficiency in portland cement, the manufacturer must be induced to burn his materials so that no seasoning is required to produce a sound cement.
   (b) Failure to meet the requirements of the accelerated tests shall (in place of "need not" as now specified) be sufficient cause for rejection.

B. Concerning the specific gravity:
   (a) In order to secure the best burning and proper storing, the specific gravity of the cement as received (i.e., dried but not ignited) shall not be less than 3.10 unless the loss by ignition is less than 2%†.
   (b) The clause "Should the test of cement as received fall below this requirement a second test may be made upon a sample ignited at a low red heat" should be omitted.
   (c) The clause "A low specific gravity in conjunction with a high loss by ignition is positive proof of undesirable burning, adulteration or seasoning" should be substituted for the present paragraphs concerning the significance of the specific gravity.

C. Concerning the fineness:
   (a) As the specifications now stand, there is little incentive to induce the manufacturer to grind to the degree of pulverization that modern improvements in grinding machinery has made practicable unless his cement is so poor that extreme fineness is necessary to enable it to pass the requirements for strength and soundness. Therefore:
   (b) That the cement shall leave a residue of not more than 5% by weight on the No. 100, and not more than 20% on the No. 200 sieve.

D. Concerning the tensile strength:
   (a) That the average of at least four briquettes representing at least two separate mixtures of the same sample shall be taken for each test, excluding any results which are manifestly faulty.

E. Concerning retests:
   (a) Manufacturers should be impressed with the fact that these are minimum requirements; that ample provision already has been made in the specifications for lack of uniformity in testing as well as in real quality; and that a quality so superior should be demanded that, regardless of the variable factors, the ability of cement to pass all requirements shall be a certainty. Therefore:
   (b) The results obtained from the original test shall be considered as final unless it becomes evident that serious error in sampling or testing has resulted in totally misrepresenting the quality of the cement. In other words, that "border-line" cements should be avoided as much as possible.

F. Concerning the practical significance of the above recommendations:
   (a) Manufacturing conditions are such that we cannot hope to secure portland cement which contains no free lime. Also, it is realized that the proposed specifications are not perfect. However, we believe that the enforcement of the above recommendations will support and promote the best practice in grinding and burning, and, accordingly, secure greater uniformity and efficiency than the present specifications.
   (b) Without the hearty, honest coöperation of both manufacturer and user little can be accomplished. The degree of fineness and burning are important financial considerations to the manufacturer, and the consumer should buy on a basis of quality.
   (c) The testing of a great number of commercial portland cements from many parts of the world has convinced us of the feasibility of these recommendations from both economic and practical standpoints, and the results obtained have disproved all claims to the contrary. For instance, a certain manufacturer in America stated that owing to a long sea voyage he could not guarantee his cement to pass the 3.10 requirement for specific gravity. Our work showed conclusively that cement stored in good barrels undergoes very little change due to atmospheric influences and many cements imported from Europe and America show consistently a gravity above 3.10 and a low loss by ignition. These are the cements which, as stated in the Introduction of our work, show the most remarkable uniformity in physical properties.

(2) We desire to emphasize the importance of the calcium hydroxideaphenol microscopic test for free lime, as in every instance the physical and chemical properties of the different products examined demonstrated the accuracy and usefulness of this test. As stated, we believe that in the hands of an expert it gives more definite and reliable information regarding the constancy of strength and volume than the usual 28-day or even 3- or 6-month tests. However, there is one undesirable feature to this test; namely, that it requires considerable experience and ability correctly to interpret the significance of the phenolate crystals formed on the microscopic slide. Therefore, in order to make this test generally practicable and universally dependable, it must be simplified or made quantitative. Certainly, its possibilities and importance warrant much more extended research in this direction than we have had opportunity to accomplish.

*One of these reports was abstracted in "Engineering News," Dec. 3, 1908, p. 612.

†The above recommendation provides for the possibility of a well-burned cement with a lower specific gravity provided the low gravity is not due to subsequent absorption of volatile constituents; but our experience does not include such a possibility.

Reinforced-concrete Trolley Poles are in use at Windsor, Ont., Canada, by the Windsor, Essex & Lake Shore Rapid Ry. They are for the span-wire suspension of a catenary system consisting of a $\frac{1}{4}$-in. standard messenger cable and No. 3-0 grooved trolley wire with hangers 10 ft. apart. The poles are 30 ft. long, set 8 ft. in the ground; those on tangents are 6 in. square at the base and are reinforced by five round steel rods $\frac{7}{8}$ in. in diameter, extending the entire length. Those on curves are 8 in. square at the top and 12 in. at the bottom, with seven steel rods. The corners of the poles are chamfered. The only trouble with these poles is that whenever a pole is leaning in the line of strain it soon gets badly out of line, owing probably to its weight. This could have been avoided by setting the poles in concrete, which was not done when they were placed originally. A. W. Westman, Superintendent, is of opinion that concrete poles, properly constructed and erected, would last longer and cost less per year per pole than either wood or steel poles.

Building a Large Railway Embankment

In connection with the construction of a large reinforced-concrete ore-dock recently built by the Lake Superior & Ishpeming Ry. Co., at Marquette, Mich. (described in our issue of Jan. 5), there was constructed an approach fill or embankment of approximately 600,000 cu.yd. This work contained several special features of interest. It was commenced Apr. 3, 1911, and finished Jan. 15, 1912. The total number of days worked, which means the number of shifts the crew was under pay, was 323. The total quantity of material moved by the steam shovel was 503,979 cu.yd., being an average of 1428 cu.yd. a day. The best monthly average was made in April, when 97,223 cu.yd. were moved in 50 shifts, making an average of 1944 cu.yd. per shift. The poorest monthly average was made in January, 1912, when 11,627 cu.yd. were moved in 12 shifts, an average of 969 yd. per shift. The work-train crew consisted of a conductor and two brakemen. The equipment consisted of a Bucyrus steam shovel, with a 3-yd. dipper, and 25 standard-gage side-dump cars of 5 and 6 cu.yd. capacity. The average haul was about 1½ miles. The material was sand, and the average face in the pit was about 10 ft.

The material was dumped from a temporary trestle consisting of two-post bents, the posts or legs being of round timbers with 8-in. tops. This trestle is shown in the accompanying cut. The caps and sills were made of old timbers, from 10x10 to 12x12 in., the sills being spliced to get the desired length. Each bent had sway-bracing consisting of small round poles. These bents were spaced about 20 ft. centers and braced longitudinally with round poles about 4-in. size at the top. One 8x16-in. stringer was used under each rail. The stringers were held in place by means of cleats spiked on top of the cap and bottom of stringer, so that the latter could be easily removed after the embankment was made. The remainder of the trestle was left in the embankment.

The trestle was not intended to carry any load except the empty dump cars, and the material was not dumped from the trestle but from the end of the embankment. The dumping was done by four men, two on each side, who knocked off the toggle chains of the cars with shovels having reinforced points, the cars being so loaded in the pit that half of the train would dump in each direction. The train of 25 cars was dumped in less than three minutes. It was then taken back to the pit, where the cars were righted by the pitman, six pitmen being employed at the shovel to take care of the extra work of righting the dump cars. The four dump men cast the earth into the center and tamped up the track while the train was gone to the pit, so that the next train would have a solid embankment to run on and would not strain the stringers. The dump men also took out the stringers (after the dump was made), in the intervals during the train's absence. This was done by digging down alongside of the stringer and rolling the stringer out while the bank was narrow. This work of taking out stringers was formerly done on Sundays, when it was necessary to get out the train crew and pull the stringers with the locomotive.

The main trouble in this method of dumping from a trestle is the danger of breaking the trestle legs and crowding them from under the cap. To prevent this, cleats were bolted to the tops of the trestle legs and extended up behind the caps. The trestle legs were supported and prevented from bending and breaking by means of ties made of six or eight strands of No. 9 binding wire about every 15 ft. in height. These ties were placed parallel to the slope of the end of the embankment, and extended from bent to bent. The natural method at first seemed to be to tie the top of each bent back to bottom of the next bent under the embankment. This method was not satisfactory, as the pressure of the settling earth would bend and break the tie wires.

The longest trestle legs used in this work were 50 ft. long, which brought the embankment to a height of 55 ft. From this point to the point at the beginning of the steel trestle, where the embankment was 70 ft. high, the bank was built across a swamp where the water was about 6 ft. deep. The base of this bank to a height of 23 ft. across the swamp was built by the Zenith Dredge Co., of Duluth, Minn., with a hydraulic dredge, the material being dredged from the harbor to form the slips at the dock. This hydraulically filled base is shown in the cut. To span an interval of swamp between the hard ground and the base put in by the hydraulic dredge, a water-jet was used to sluice material into place from the dump.

BUILDING A LARGE EMBANKMENT BY PUMPING FOR THE BASE AND DUMPING FROM CARS FOR THE UPPER PART; LAKE SUPERIOR & ISHPEMING RY.

Two men, using ordinary fire hose, washed the material ahead in troughs as it was dumped from the cars, so as to form a base upon which to build the temporary trestle. The troughs were of corrugated iron. By this method only three men were employed on the dump instead of four, and the work went on nearly as fast as usual. A part of the time the work was carried on at night, and the records show that fully as much work was accomplished at night as in the day time, with no additional expense.

In order to carry on the work without interruption while the hydraulic dredge work was in progress, sub-bents were jetted into the base fill which was in process of construction and the temporary trestle built on these. The accompanying cut shows the base built by the suction dredge with the slope maintained by means of levee boards. The discharge pipe is just in front of the post at the left of the cut. It also shows the temporary trestle and the sub-bents jetted into the base fill. All of the work was done by the company's forces under the engineering department. E. C. Watson, Roadmaster, had direct charge of the work. For information as to the work we are indebted to R. C. Young, Chief Engineer, Lake Superior & Ishpeming Ry.

Studies of Fish Life and Water Pollution*

By H. W. Clark† and George O. Adams‡

The effect of sewage, trade wastes and the effluents from sewage filters upon fish life has received little investigation in this country, although it is known, of course, in a general way that owing to increasing pollution, fish have disappeared from many streams in which they were formerly abundant. The effect of sewage pollution upon shellfish and the areas from which shellfish are taken has been investigated during the past 10 or 15 years chiefly because shellfish are likely to be the bearers of infectious diseases.

From a practical viewpoint, the question of fish life in streams and lakes in a settled community is one of the value of such life in a certain stream or lake compared with the cost of maintaining such freedom from pollution or such restriction in the use of streams as will allow the continuance of this life. It goes without saying that looked at in this way, the cost of preserving a stream in a condition that allowed fish life might be exceedingly large as compared with the value of the fish saved. This would be especially true in manufacturing districts, as in such places the streams are chiefly valuable for power and the carrying away of the waste products of the district more or less purified. Treating these wastes sufficiently to prevent the stream from becoming a nuisance, moreover, may not keep it sufficiently pure to encourage the life of fish within it and many streams seem fated to become sources of power and the carriers of wastes, and find their chief value when so used. Practically all that can be expected in many instances is that the sewage or wastes entering such streams shall at all times of the year be so purified before entrance or so diluted by the flow of water that the stream will not be a nuisance to the community through which it flows but rather a source of enjoyment to such community.

From a scientific standpoint there are a number of questions to be considered in this study of pollution and fish life, the most important being as follows: (1) The amount of pollution that a stream may receive without decreasing the dissolved oxygen of the water to such a degree that fish can no longer live in the water; (2) the effect of the various constituents of sewage and trade wastes upon fish and the effect of these various constituents upon fish even when a plentiful supply of dissolved oxygen remains in the water after receiving these wastes; (3) the amount of oxygen consumed by the fish themselves; and (4) the rate of absorption of oxygen by polluted waters.

At the Lawrence Experiment Station of the Massachusetts State Board of Health a series of investigations in regard to these questions has been carried on during the past year and the following paper describes a portion of these investigations. The experiments have been made largely in 5-gal. glass aquaria and some of the commonest fish of the region—shiners, suckers, chub and carp—have been used. Most of the cary and shiners have weighed from 1 and 2 oz. each, while the suckers have weighed from ¼ to ½ lb.

EFFECT OF SEWAGE

In the first experiments, the fish were immersed in undiluted Lawrence sewage, well aërated, and containing at the time of immersion from 50 to 100% of saturation of dissolved oxygen. Notwithstanding the presence of this dissolved oxygen, all the fish in these experiments apparently became crazed when immersed and died almost immediately, that is, within a few minutes after immersion.

EFFECT OF EFFLUENTS FROM SEWAGE FILTERS

Following this, experiments were made with the effluents from sand, contact and trickling filters and with mixtures of sewage and water, contact-filter effluents and water, and trickling-filter effluents and water (for analyses, see Table I). In this series of experiments a supply of dissolved oxygen was maintained when necessary by blowing air through the liquid used. The results were as follows:

(a) It was found that when water and sewage of the strength used were mixed in equal portions and this mixture kept aërated, fish life could exist almost indefinitely, but with a larger proportion of sewage the fish died within a few minutes, or at most, in an hour or two after their immersion. Even in the equal mixtures of sewage and water, a number of fish died quickly and only the stronger individuals survived, but such as did survive were kept in this mixture alive and well for 14 days, and apparently could have continued to live for an indefinite period. The sewage used was freed from matters in suspension before being mixed with the water.

(b) It was found that aërated effluents from contact and trickling filters in successful operation supported fish life for 14 days without any apparent discomfort to the fish immersed in these effluents.

EFFECT OF SEWAGE AND EFFLUENTS WHEN NONAERATED

Experiments were next made to determine the volume of water (tap water) necessary to mix with sewage and the effluents from trickling filters in order that fish life could be sustained under what might be called stagnant conditions, that is, sustained without the introduction of dissolved oxygen by aëration as in the previous experiments. After several trials it was found that but 10% of sewage could be mixed with 90% of water and the fish survive in good condition for 14 days. Increasing the sewage above this percentage invariably caused the exhaustion of the oxygen and the death of the fish within a few hours. It was found that only 25% of water was needed in 75% of the best trickling filter effluents in order that fish might live under these stagnant conditions for 14 days, this mixture always containing enough oxygen to support life, and the effluent present having apparently no harmful effect upon the fish. With the contact filter effluents equal mixtures were necessary, that is, 50% of the effluent to 50% of tap water.

LIMIT OF DISSOLVED OXYGEN

At the beginning of the last experiments described, that is, at the time of the immersion of the fish, the dissolved oxygen in the mixtures was 0.5 part per 100,000. During the experiment it became reduced in the water and effluent mixture to as low a point as 0.11 part per 100,000, and in the mixture of sewage and water, to 0.14 part per 100,000, but without any apparent discomfort to the fish in these mixtures.

The greatest consumption of oxygen by the organic matter present in such mixtures occurs in the first few hours, and it was found that if the initial supply of oxygen was great enough to last through this early period, the oxygen would then be increased by absorption from the air.

In a third experiment of this nature, where a mixture of equal portions of tap water and trickling filter effluent was made, the dissolved oxygen at the start was 0.80 part per 100,000, and was not reduced below 0.40 part per 100,000 during the 14 days of the experiment.

In further investigations in regard to the amount of dissolved oxygen that would sustain fish life, the following three experiments were made: Sewage of the strength shown in Table II was so mixed with water that three dilutions containing 5, 10 and 15%, respectively, of sewage were obtained. In these dilutions the dissolved oxygen was at first 0.88, 1.00 and 0.85 parts per 100.000. In each dilution fish were immersed and in each of the three dilutions they lived for one week without discomfort, that is, until the end of the experiment.

TABLE I. ANALYSES OF SEWAGE-FILTER EFFLUENTS, MIXTURES OF WATER AND SEWAGE AND MIXTURES OF WATER AND SEWAGE FILTER EFFLUENTS USED IN STUDIES OF FISH LIFE AND WATER POLLUTION

(Parts per 100,000)

	Contact-filter effluent		Trickling-filter effluent		Equal mixture of water and sewage		Water and 10% sewage		Water and 75% trickling-filter effluent		Water and 50% trickling-filter effluent	
	At start	After 14 days	At start	After 14 days	At start	After 14 days	At start	After 14 days	At start	After 14 days	At start	After 14 days
Free ammonia	1.5500	2.8000	1.8000	2.8800	1.9000	2.8000	0.5500	0.6600	1.2000	1.8800	1.3000	1.2600
Albuminoid ammonia,												
Total	0.2700	0.2880	0.2800	0.3480	0.2100	0.2280	0.0440	0.0620	0.0960	0.1720	0.1260	0.1000
In solution	0.1540	0.1840	0.1800	0.1220	0.2100	0.1480	.....	0.0300	0.0960	0.0820	0.0840	0.0720
Chlorine	11.30	12.40	10.70	12.10	7.30	7.00	1.60	2.00	7.20	7.10	6.50	6.50
Nitrogen as												
Nitrates	0.03	0.04	2.01	2.12	0.02	0.02	0.06	0.06	2.09	1.81	0.67	0.50
Nitrites	0.0000	0.0000	0.0100	0.0600	0.0024	0.0180	0.0000	0.0036	0.0064	0.0380	0.0015	0.0340
Oxygen consumed	1.78	1.80	1.82	2.22	1.24	1.46	0.63	0.67	0.90	1.00	1.00	1.04
Solids in suspension,												
Total	.....	.....	.....	.....	0.0	2.3	.....	.....	0.0	1.9	.....	.....
Volatile	.....	.....	.....	.....	0.0	2.2	.....	.....	0.0	1.6	.....	.....

*A paper read before the International Congress of Applied Chemistry, New York City, September, 1912.

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The minimum amount of dissolved oxygen found during this period in each of these dilutions was 0.47, 0.28 and 0.15 part per 100,000, respectively.

TABLE II. ANALYSIS OF SEWAGE USED IN DILUTIONS CONTAINING 5, 10 AND 15% OF SEWAGE

(Parts per 100,000)

Ammonia			Kjeldahl Nitrogen			
	Albuminoid					
Free	Total	in solution	Total	In solution	Chlorine	Oxygen consumed
5.80	0.86	0.35	1.38	0.79	12.40	4.40

EFFECT OF SAND-FILTER EFFLUENTS

In six experiments in which fish were immersed in well-purified, highly nitrified effluents from sand filters receiving sewage (see Table III for analyses), the three fish immersed in each experiment died in from three hours to three days after immersion. All of these effluents but one were clear but slightly acid, this acidity being due to insufficient base to combine with the nitric acid present. One effluent was alkaline, but contained considerable matter in suspension, this matter being largely silica and alumina. When this suspended matter was removed the fish lived in this effluent without any apparent discomfort for 14 days, or during the length of the experiment. Other acid effluents from sand filters when neutralized and filtered to remove precipitated $CaCO_3$ and $MgCO_3$, etc., supported fish life. The alkaline suspended matters at times separating from such effluents and from sewage, gathering at the outlet of the fish's gills and at the joints in their scales, gave the appearance of a fungus growth upon the fish.

TABLE III. ANALYSES OF EFFLUENTS FROM SAND FILTERS RECEIVING SEWAGE

(Parts per 100,000)

	Ammonia			Nitrogen as			
No.	Free	Total albuminoid	Chlorine	Nitrates	Nitrites	Oxygen consumed	Alkalinity
1	0.4800	0.0540	9.00	5.21	0.0024	0.23	—0.9
2	0.9600	0.0960	7.30	1.64	0.0032	0.51	—0.3
3	0.9600	0.0960	9.40	2.17	0.0120	0.54	1.0
4	0.0628	0.0194	9.00	4.62	0.0002	0.17	—0.2
5	1.0400	0.0460	7.10	6.13	0.0012	0.45	—1.5
6	0.2505	0.0290	7.00	1.64	0.0380	0.29	—0.2

EFFECT OF NITRATES, IRON, POTASSIUM CARBONATE, ETC.

It would seem without doubt that the alkaline suspended matter and the acidity of the effluents in the experiments just described were responsible for the death of the fish immersed in these effluents.

Fish immersed in water containing 5 parts of nitrogen as potassium nitrate lived without any apparent discomfort, and in water in which organic matter, etc., had been coagulated by the use of 1.5 grains of alum, they lived two weeks without discomfort.

In water treated with ferric sulphate they became covered with a fungus-like growth and died in a few days. The iron in solution may have been the cause, as apparently fish are extremely sensitive to iron salts, as will be shown later.

Free nitric acid in tap water in amounts equal to 0.7 part per 100,000 $CaCO_3$ was without effect.

Very small amounts of hydrochloric acid, equivalent to about 0.5 part per 100,000 alkalinity, caused the death of fish in a few hours.

When the experiments with nitric acid were made, it was found that the small fish used not only neutralized the acid but made the water alkaline. The water was acidified five times and each time was rendered alkaline by the fish present. In 12 days the fish experimented with had neutralized acid equal to 2.7 parts per 100,000 $CaCO_3$ in about 1500 c.c. of water, leaving a residual alkalinity of 1 part per 100,000.

"Free Ammonia" in sewage is supposed to consist in part of carbonate, and it was found that from 5.5 to 7 parts of ammonia as carbonate in well aërated tap water was fatal to shiners and carp in from a few minutes to a few hours. Ammonia in the form of chloride up to 18 parts per 100,000 had no ill effect on the fish. When used in the form of ammonium hydrate, the ammonia was much more deadly, 2 parts per 100,000 killing shiners, carp and large suckers in 15 minutes. The fatal amount was probably slightly over 1 part per 100,000 as the fish experimented with were unaffected in water containing 0.94 part per 100,000 but died in water containing 1.3 parts per 100,000.

It should be noted in passing that the ammonium hydrate was soon changed in water to the less injurious carbonate by the free carbonic acid present and by carbonic acid given off by the life of the fish.

The effect of caustic and carbonate alkali was next tried. Pollution of this nature comes from a number of industrial processes and at times may be serious before sufficient dilution by the water in a stream takes place to render it harmless. It was found that from 25 to 30 parts per 100,000 $NaCO_3$ per 100,000 killed fish within a few hours. Seven parts of NaOH killed several fish in two hours and 9.6 parts per 100,000 killed two in ten minutes. In water containing 5.6 parts per 100,000, fish lived 24 hours.

It was noticed in this work that fish immersed in sodium carbonate solutions, rendered these solutions less poisonous to fish subsequently immersed in them, this being due probably to the change from carbonate to bicarbonate. As a proof of this, it was found that bicarbonate of soda was the least injurious form of alkali experimented with, fish living easily in water containing 120 parts per 100,000.

The effect of iron salts was next investigated, these salts being dissolved in distilled water to prevent precipitation such as would occur in tap water on account of the alkalinity of this tap water. Copperas equivalent to 0.128 part per 100,000 of iron killed fish in from 4 to 24 hours, one fish living without trouble in water containing 0.100 part per 100,000. In such dilute solutions, however, the iron gradually precipitates even when dissolved in distilled water.

In solutions of ferric sulphate fish died in from ½ to 3 hours when 0.1080 part iron per 100,000 was present, and in from 12 to 24 hours when as little as 0.0100 part per 100,000 was present.

CONSUMPTION OF OXYGEN BY FISH LIFE

The large amount of dissolved oxygen consumed by fish is little realized. In studying this point, the following experiments were made: Thirteen small fish weighing altogether 200 grams, were placed in a saltmouth gallon bottle filled with water, and the dissolved oxygen determined at the beginning and at the end of the experiment.

In a second experiment four fish weighing 340 grams were used. In all, nine experiments of this kind were made. Averaging these experiments it was found, speaking generally, that all the oxygen held in solution in a gallon of water at 60° F.—practically one part per 100,000—would be consumed or breathed in one hour by a weight of fish equal to 1 lb. This would mean that 1000 lb. of fish life would in about 15 days exhaust the dissolved oxygen in a layer of water 1 ft. deep and an acre in area, saturated at 60° F., assuming, of course, that dissolved oxygen was not added by absorption from the air. The oxygen consumed in this way remains in the water as CO_2, and hence the amount of CO_2 in surface waters sustaining fish life must be influenced to a considerable extent by the fish present.

SOLUTION AND DIFFUSION OF OXYGEN IN WATER.

There are few good data in regard to the rate of solution and diffusion of oxygen in water. E. A. Letts, in the "Journal of the Royal Sanitary Institute," Vol. XXXIII, No. 1, states that Dr. Adeny found that ten days were required to saturate with oxygen a sheet of water at a temperature of 15° C., 6 ft. in depth, and deprived of all atmospheric gases.

The following experiments made by us give some idea of the rate of aëration of a quiet, shallow sheet of water. In the first, a small fish, weighing 25 grams, was immersed in an aquarium holding 7 in. in depth of tap water. Experiments had shown that a fish of this size in this volume of water would reduce the dissolved oxygen primarily present about 0.26 part per 100,000 per day.

Table IV presents the amount of dissolved oxygen found in the water in the aquarium on different days during a period of 34 days, together with a column showing the amount of oxygen consumed by the fish during that period. From this table it will be seen that oxygen was absorbed by the water at about the same rate that it was consumed by the fish.

TABLE IV. DISSOLVED OXYGEN IN AQUARIUM WATER AND USED BY FISH WHILE IN AQUARIUM, IN PARTS PER 100,000

	Dissolved oxygen	
Days	In aquarium	Used by fish
1	0.37	0.26
2	0.40	0.52
3	0.45	0.78
5	0.22	1.04
14	0.49	3.18
22	0.40	5.48
29	0.50	7.08
34	0.31	8.58

In a second experiment the dissolved oxygen in an aquarium of tap water was reduced to 0.11 part per 100,000 by the fish in this aquarium. The fish were then removed and the aquarium allowed to stand in the laboratory open to the air, and determinations of dissolved oxygen made from time to time. The results of these determinations are shown in Table V, and it will be noticed that practically seven days

were required for this water to again become saturated with oxygen.

TABLE V. DISSOLVED OXYGEN IN AQUARIUM CONTAINING FISH AFTER 2 TO 10 DAYS

Days	Temperature, deg. F.	Dissolved oxygen: Parts per 100,000	Dissolved oxygen: Per cent. saturation
2	68	0.38	41.3
3	65	0.72	74.7
4	64	0.76	79.2
5	66	0.80	85.0
6	67	0.88	94.5
7	70	0.94	104.0
10	65	1.00	105.0

During the last part of this experiment, "green growths" (Scenedesmus and Protococcus) made their appearance in this water.

LIBERATION OF OXYGEN BY "GREEN GROWTHS"

It is well known that organisms containing chlorophyll give off free oxygen when growing in the light. Water in which organisms are plentiful is frequently found to be supersaturated with disolved oxygen as the organisms take the C fro mthe CO_2 dissolved in the water, and liberate part of the oxygen. When the dissolved CO_2 is all absorbed the bicarbonates are attacked and CO_2 abstracted, leaving carbonates. This happened several times in experiments here. On testing for CO_2 with phenolphthalein, a pink color showed the presence of carbonates, while in the tap water used in the various experiments, the alkalinity was due to bicarbonates. In the experiments the "green growths" were largely Protococcus, Scenedesmus and smaller numbers of Monas. In one experiment an aquarium was filled with tap water and seeded with "green growth." The disolved oxygen and CO_2 at the start were 0.18 and 1.00 part per 100,000, respectively. At the end of seven days, they were 1.14 and 0 parts per 100,000, respectively.

In another experiment a small fish was put into a tightly stoppered gallon bottle full of water containing these "green growths." If oxygen had not been liberated by the organisms during this experiment, the oxygen primarily present would have been consumed by the fish in 38 hours. However, it lived eight days and at its death at the end of this period, dissolved oxygen was present in the water in greater volume than at the beginning of the experiment. The growth of organisms increased greatly during this period, and either the presence of these organisms or some body formed during their growth or decay, was injurious to the fish.

In a similar experiment made during cloudy weather when the oxygen-liberating power of the organisms was lowered, the fish present consumed the dissolved oxygen in four days.

In further experiments, not yet completed, upon the effect of such "green growths" on sewage, bottles of sewage were seeded with organisms, then aërated for 24 hours, and afterwards allowed to stand 24 hours with aëration. The average of 16 dissolved oxygen determinations then made showed 0.62 part per 100,000 of dissolved oxygen present in these sewages at the end of the period of aëration and 1.01 parts per 100,000 after the sewage had stood unaërated during an additional period of 24 hours; in other words, the "green growth" supplied not only all the dissolved oxygen consumed by the sewage during the period of standing, but, furthermore, increased the volume present 0.39 part per 100,000.

It is probable that the chlorophyll-bearing organisms take a greater part in overcoming sewage pollution in surface waters than is at present generally realized.

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Merits of Different Woods for Street Paving*

By H. G. Davis†

The success of a creosoted wood-block pavement depends principally upon four fundamental features: 1, the quality of the wood; 2, the characteristics of the oil used; 3, the method of treatment; 4, the construction of the pavement. While it is probably true that the first three are of equal importance and the fourth is of major importance, this paper has to deal with the first, or the quality of the wood selected for the pavement.

Failures of street pavements frequently are attributed to causes which have nothing to do with the failures. In the case of a street in Chicago where gum wood was used, the timber was condemned and struck from the specifications because of defects appearing which were attributed (probably without the slightest reason) to the wood itself. As another instance, the weeping or bleeding has been attributed universally to the nature of the oil, and few engineers have attempted to charge it to any other cause. About three years ago, the writer heard M. Rinker, City Engr. of Minneapolis, state that there had been no trouble from bleeding in some 700,000 sq.yd. of creosoted blocks laid in that city. Since then a change has been made in the timber specifications, while the oil is practically the same, and now there are complaints of bleeding. As usual this has been attributed to the oil and no one has suggested that the wood is in any way responsible for the condition.

In selecting a wood for paving purposes, three things should be taken into consideration; 1, its adaptability to the purpose; 2, its availability; and 3, the commercial conditions. By adaptability is meant both the probable service that will be given by the blocks, as well as the natural characteristics of the wood with respect to the manufacture of the blocks. It is, of course, necessary to select a wood which is sufficiently strong in texture to withstand the effects of the traffic and give a long life to the pavement. Engineers in this country have been making long-leaf yellow-pine the standard of perfection in a paving block, and this wood has been used in probably 75% of the creosoted block pavements laid prior to 1911. Then it was decided that a short-leaf pine might be used if of close growth. The change was a wise one, as the short-leaf pine, while not so strong a wood as the long leaf, is sufficiently strong for a paving block. There is a great deal of difference in the characteristics of the two woods: Long-leaf pine weighs 43.6 lb. per cu.ft. against 38 lb. for the short-leaf, and the specific gravity is 70 and 61 respectively.

The foregoing is cited to show that in selecting a wood for paving purposes it is not necessary to require one of the greatest possible strength to withstand the stress to which it will be subjected under traffic. In the Central West we have at least four woods which are suitable for paving purposes; southern yellow-pine, tamarack, hemlock and maple. The writer has had no opportunity to study the Norway pine. The one street paved in Chicago with gum is not considered a sufficiently conclusive experiment to warrant a definite opinion. Maple is the wood most easily treated, followed closely by tamarack and hemlock, all three greatly outclassing yellow-pine in this respect.

For the past ten years, Chicago has confined its wood-block pavements almost entirely to yellow-pine, and in fact all the streets laid prior to 1912 were yellow-pine with the exception of about 1500 yd. of gum and about 8000 yd. of street-car track paved with tamarack. In the past year we have laid a test intersection with maple and about two miles of tamarack. The yellow-pine has given excellent satisfaction on some of the heaviest traffic streets in the country.

About five years ago the Chicago Railways Co. used some tamarack blocks in paving its tracks on Dearborn St., north of Van Buren St. Although the construction of this pavement is open to considerable criticism, especially the treatment around the tie-rods, yet the pavement is in excellent condition and shows just as good results as have been obtained from yellow-pine blocks.

A little more than a year ago, our company furnished hard-maple blocks for the intersection of Madison St. and Fifth Ave. This is one of the heaviest traveled spots in Chicago, and it is estimated that the daily vehicle traffic is 8000 and 5000 on the two streets, respectively. These blocks do not show the slightest sign of wear. In fact, so satisfactory was the result that the Chicago Railways Co. specified maple when purchasing its entire supply for 1912. As to hemlock, I call attention to the results shown in the test pavement laid in Minneapolis under the supervision of the U. S. Government. In a seven-year test, hemlock shown only $\frac{1}{16}$ in. more wear than the long-leaf yellow-pine.

As to availability, it is necessary to be assured that the supply is sufficient to fill the demand, and in considering this phase of the subject it is well to look to the future. It is most important to take into consideration the commercial conditions surrounding the timber selected, for the pavement must be constructed as cheaply as possible, commensurate with the quality required. As an illustration, in Chicago, in 1912, every ordinance called for southern yellow-pine or woods equally good for paving purposes. Prices in the yellow-pine market went high early in 1912, and as a result wood-block pavements broke all records for high prices to the consumer and small profits to the manufacture. Tamarack was not affected, and we sold all we had. But while these prices were soaring we were vainly struggling with the city to permit us to deliver hard-maple, which could be purchased at a lower price than yellow-pine or tamarack.

*Abstract of a paper read at the annual meeting of the American Wood Preservers Association, at Chicago, Jan. 21-23.

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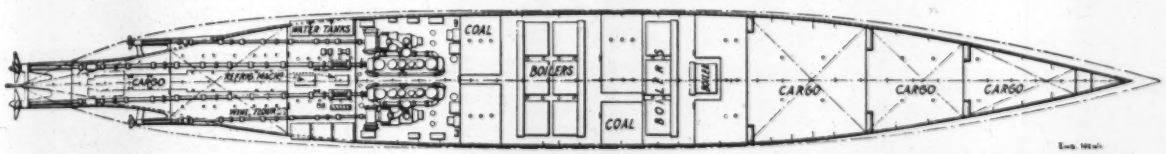
A Transatlantic Steamship with Reciprocating Engines and Exhaust Turbines, the "Rochambeau"

The quadruple-screw steamship "Rochambeau" of the Compagnie Generale Transatlantique has recently been completed by the Société Anonyme des Chantier et Ateliers de St. Nazaire. This boat is of 17,000 tons gross register, and is propelled by two reciprocating engines on the inner shafts, exhausting into turbines in each wing, driving outer propellers. There are five decks, a central deckhouse over which is the boat-deck, and above this the bridge, captain's cabin, deck officers' quarters, and the wireless-telegraph station. The hull throughout is of open-hearth steel with a double bottom running the whole length of the ship and forming water-ballast tanks. The length of the boat between perpendiculars is 535 ft.; the extreme breadth is 63 ft. 7 in.; the mean loaded draft is 26 ft. 10 in.; the cargo capacity is given as 332,580 cu.ft. and the boat carries 274 officers and crew, 428 cabin passengers, 200 third-class, and 1248 steerage.

The double bottom consists of seven separate compartments, each of which can be filled and emptied independently. Those compartments under the forward stokehold are set apart for fresh water for the boilers, and have a capacity of about 7800 cu.ft. The compartments under the aft stokehold have a capacity of about 13,700 cu.ft. and contain fresh water for washing decks.



HOLD PLAN OF THE QUADRUPLE-SCREW STEAMSHIP "ROCHAMBEAU," SHOWING ENGINE AND BOILER LAYOUT

The ship is steered by steam gear of the usual type, mounted aft of the upper deck. The vessel is lighted throughout by 110-volt direct current from three generators, driven by vertical steam engines.

The main reciprocating engines are of a triple-expansion, four-cylinder type with a high-pressure cylinder diameter of 34.6 in.; the diameter of the intermediate-pressure cylinder is 50.8 in., and the low-pressure cylinder 57.5 in. The stroke is 39.4 in. The low-pressure cylinders are at each end of each engine; steam distribution to the high-pressure and intermediate cylinders is by piston valves in chests, side by side at the center of the engines. The low-pressure cylinder has slide valves in check at each end. All valves are operated by eccentrics and link motion. The crank shaft is 16.1 in. in diameter, carried in six bearings.

Each of the two wing-shaft turbines takes exhaust from the reciprocating engine on the same side of the ship. The turbine is mounted alongside of the reciprocating engine, an arrangement which is considered by the builders to be preferable to having two reciprocating engines exhausting into a single turbine.

The result of the trial trips is reported satisfactory. The stipulated speed of the contract was 17 knots with a coal consumption of 14,800 lb. per hr. for the main units only. The average speed actually attained was over 17½ knots with a coal consumption of only 14,100 lb. On the first run, at a speed of 17.65 knots, 13,222 hp. was developed. The high-speed propeller showed 411 r.p.m. and the low speed, 108.6. On a run at 17.78 knots these various figures were 13,398 hp., 413.2 and 108.2 r.p.m. respectively. The slip of the engine-driven propellers was 4.12% and of the turbine-driven 24%.

The turbines are of standard Parsons type, with a drum 67 in. in diameter carrying 48 rows of blades. There is an unbalanced thrust of the turbine rotors which is approximately equal to the propeller thrust in the opposite direction. The turbines are not used for maneuvering purposes so that no reverse sections are provided. This shortens the casing, making it practicable to construct top and bottom parts as single castings.

The engines are supplied with steam from nine boilers each with four furnaces working on a forced-draft system. The working pressure is 205 lb. per sq.in. The diameter of the boilers is 16 ft. 9 in., with a length of 11 ft. 6 in. and a total heating surface of 26,800 sq.ft.

Numerous illustrations of this boat with accompanying text are found in London *Engineering*, Nov. 22 and 29, 1912.

⁂

The Government Stream Gaging Work—Before Major J. W. Powell, of the U. S. Geological Survey, had the matter of stream measurement taken up by that bureau, no systematic studies of the water resources of the United States were being made. The work inaugurated by him and continued under his successors, Chas. D. Walcott and Geo. Otis Smith, has borne good fruit. Engineers throughout the width and breadth of the land have constant occasion to refer to the results of these studies. And yet these studies are not as broad and extensive as they ought to be. They should, as you all know, be carried on on a much larger scale than at present.

The engineer, whose problem relates to the utilization of run-off waters, or to the protection of lands against inundation, or to the improvement of river channels, searches the records as far back as they go and wishes for more. He is bound to do this. He cannot at a moment's notice go afield and gather adequate reliable facts by an examination of the stream. Nature does not put the stream either into its extreme low stage nor yet into its maximum flood stage just to accommodate the engineer who wants knowledge of these extreme conditions.

For such information the records supplied by the U. S. Geological Survey are invaluable. A stream may be in maximum flood only once in a century. Shall the engineer conjecture what this may be, or will the nation make and maintain adequate provision to gather such data and have them ready and easily accessible when they are required? Such questions as this prompted the U. S. Geological Survey, under able leadership, to take up and to continue the work of measuring streams. And yet almost annually there is an attempt made in Congress to curtail, or to cut out altogether, the already inadequate annual allowance of some $150,000 or $200,000 for a continuance of the work of the Water Resources Branch of the U. S. Geological Survey. And the question is asked, and with some reason too, "What has the Geological Survey to do with stream gaging?

This bureau, under the Secretary of the Interior, has had the wisdom to recognize the importance of this work and has had the courage to take it up because there was no one else to do it, because there was no properly organized department of public works in our scheme of government. The Geological Survey deserves full credit for its foresight and should receive every needed assistance.

The Municipal Quay Wall, Oakland, California

By Thomas E. Risley*

One of the units of Oakland's comprehensive development of her water front is the quay wall. This wall (Fig. 1) is located on the southern side of the city, on what is known as Oakland Harbor, and is 2005 ft. in length.

The wall (Fig. 2) is of the gravity type, with a width of 22 ft. at the bottom and a height of 44 ft. The bottom is 33.2 ft. below mean low tide. From borings (Fig. 1) before the plans were drawn, it was determined that the foundation would be fine sand cemented with approximately 10% clay, firmly compacted. Excavation in the construction of the wall bore out this fact, so no other foundation was necessary.

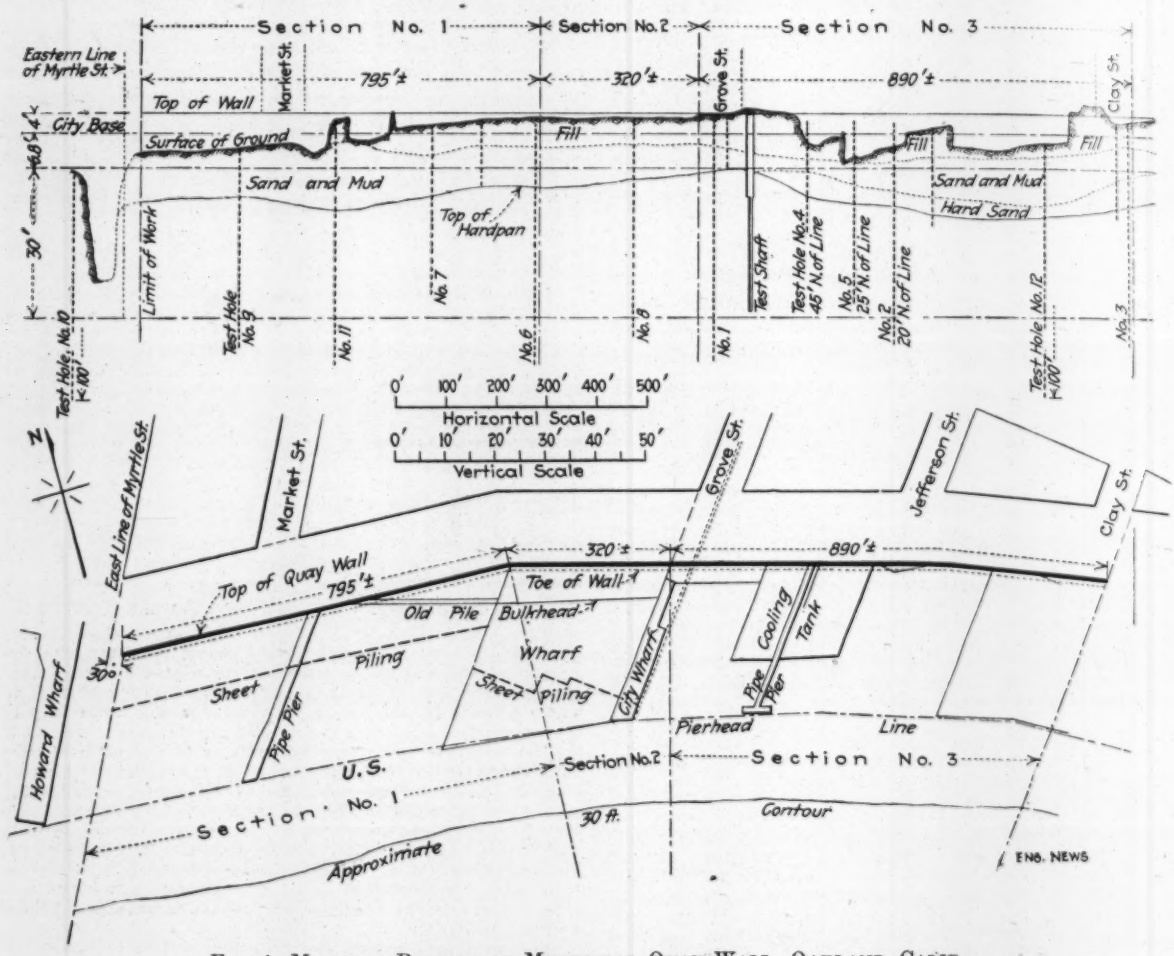


Fig. 1. Map and Profile of Municipal Quay Wall, Oakland, Calif.

Excavation—Before excavating, a row of standard sheet-piling was driven on either side of the center line of the wall, 40 ft. apart. The excavating was performed by the application of the early California method of mining, namely, hydraulicking. The hydraulic plant consisted of a 4-stage 8-in. discharge Krogh centrifugal pump, with a 10-in. intake, directly connected to a 300-hp., General Electric, 3-phase, 60-cycle, 220-volt induction motor, placed on a small barge and moored several hundred feet from the site of the work, in deep water. A pipe line, varying in length from 300 ft. to 900 ft. as the work progressed, delivered the water to a Hendy hydraulic giant fitted with a 1¾-in. nozzle, at the rate of 500 gal. per min. at a pressure of 175 lb. per sq.in.—which was found in most instances to be a sufficient pressure to break down the bank. When very hard material was encountered a few light shots of powder were used to shake up the ground. After shooting it was found that the volume of water as supplied by the monitor was not sufficient to carry off the finely divided material so an auxiliary pump was rigged to supply the necessary quantity. From the face of the cut the material flowed back to a sump from which it was pumped out of the trench by an 8-in. pump driven by belt from a 75-hp. Westinghouse, 3-phase, 220-volt induction motor. The point of discharge was frequently 900 ft. from the sump.

After a depth of 20 ft. had been reached a second system of sheet-piling was used. This was placed on the neat lines of the bottom section of the wall and was driven only as the excavation proceeded. Sufficient bracing was used to keep it in place and to prevent the occurrence of slides.

When the excavation had reached a point within 2 or 3 ft. of grade a narrow trench was excavated along the center at grade in which was placed a sluice box 2 ft. wide, with sides 12 in. high. Into this box laborers shov-

*Assistant Engineer, Office of City Engineer, Oakland, Calif.

eled material—the monitor was turned into the box and the material washed to the sump. Owing to the fact that the grade of the entire wall is level, the work was divided into sections 160 ft. in length. Upon completion of the section the equipment was moved ahead and a

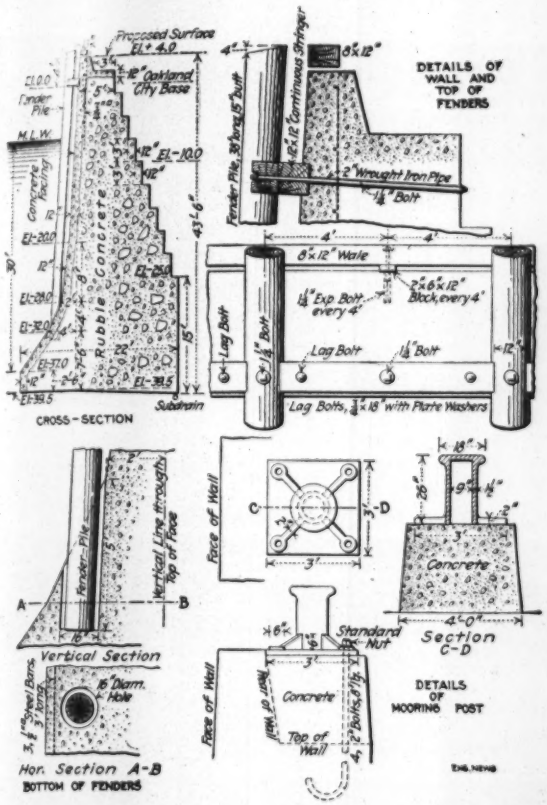


FIG. 2. SECTION OF OAKLAND QUAY WALL AND DETAILS OF FENDERS AND MOORING POSTS

small embankment of sacks filled with earth was placed across the trench separating the new sump and the completed trench.

CONCRETE WORK—After the removal of the excavating equipment there was placed over the trench a platform that carried a double track on which concrete was brought from the concrete-mixer plant in trains of 3 to 4 side-dump Koppel cars drawn by a horse. The concrete was dumped into a hopper to which was hung a 6-in. tube. The concrete was distributed by moving the discharge end to the position desired. As the concreting was in progress large rocks to the amount of about 25% by volume were deposited in the green concrete. Owing to the existence of braces in the trench it was found impossible to pour a single section of the wall monolithic (the limits of length of a section were 16 to 50 ft). The result was that each section was poured its full length to a height of 6 ft. (the braces being 6 ft. apart) then allowed to set 24 hr.—the braces removed and the sheeting braced against the wall—forms were then placed and the pouring continued.

To attain a key and bond between these horizontal layers care was taken to place large rocks, from 1 to 5 ft. long, on the top of the layer before the concrete had set. These were imbedded about one-half their thickness. Also 1 ft. from the rear of the wall were placed ¾-in. bars, 30 in. long, 12 in. c. to c. Before concrete was added to the layer the surface was thoroughly cleaned with a wire broom, then wet and sprinkled with neat cement. The result of this method of bonding has proven satisfactory.

The plans and specifications called for concrete of two grades—rubble concrete and facing concrete. The rubble concrete consisted of a mixture of one bag of cement (containing 94 lb.) and 9 cu.ft. of aggregate. The aggregate was composed of one part sand and two parts broken stone. It was of concrete of this composition that the bulk of the wall was constructed. The facing concrete consisted of a mixture of one bag of cement (containing 94 lb.), 2½ cu.ft. of sand and 5 cu.ft. of rock. The broken stone in each case was ¼ in. to 2 in. in size. This richer mixture was used on the outside face to a thickness of 12 in. and a top capping 3 ft. deep. Considerable difficulty was encountered in placing the facing concrete. Great care was taken to insure that the full quantity was placed, with no intermixing of the two grades and still with no line of cleavage. The problem was finally solved at the expense of the contractor, in that he banked the richer grade against the form in excess quantity and allowed the leaner grade to flow to it until there remained a 12-in. section.

The different sections of the wall were keyed together by having a recess 3 ft. wide and 6 in. deep cast in the end of each section. This recess extended from the bot-

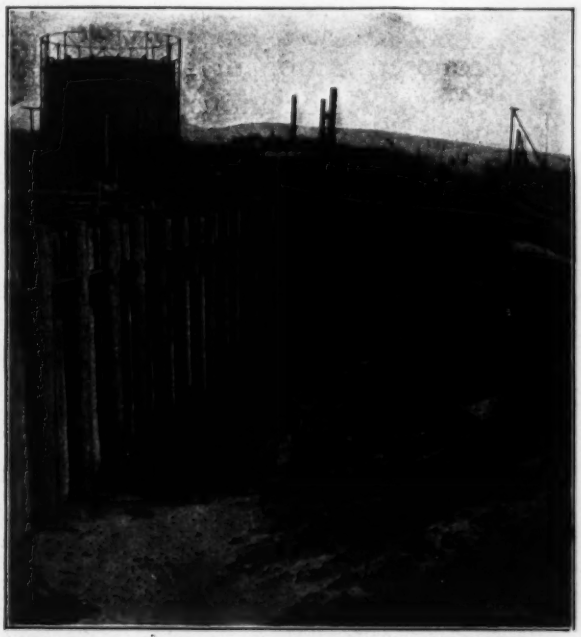


FIG. 3. VIEW OF PORTION OF OAKLAND QUAY WALL AFTER COMPLETION

(The material at the right is yet to be removed to a level 30 ft. below low tide.)

tom to within 8 ft. of the top. On pouring the next section the concrete was poured into this recess, completing the key. No effort was made to cause the new section to bond to the old.

FENDERS AND OTHER DETAILS—The fender line (Fig. 2) has been designed so that replacements may be readily made and at small cost. The fender piles, spaced 8 ft.

c. to c., are placed in sockets cast in the outward toe of the wall and fastened at the top by means of a 1¼-in. machine bolt that projects through the wall, being incased in a 2-in. pipe. Between the pile and wall and 3 ft. from the top there has been placed in a recess, 2 in. deep, a 12x12-in. continuous stringer. An ordinary chock has been placed between the piles.

On the top of the wall there is an 8x12-in. "backing piece" held up 2 in. by means of blocks. This "backing piece" is held in place by means of expansion bolts in holes cast in the concrete every 4 ft.

Cast-iron mooring bits, spaced 75 ft. apart, are bolted on the top of the wall, as shown in the detail in Fig. 2. The bolts were cast in the concrete.

A section of the completed quay wall is shown by the view, Fig. 2.

Back of the wall the city of Oakland has acquired a strip of land, 150 ft. wide, on which plans call for a section of the Belt Line Ry. (which will eventually circle the water front, of which Oakland has 20 miles), the necessary sheds, roadway and freight machinery.

Before the wall can be used it is necessary that some dredging be done. A depth of 30 ft. of the water at low tide will be attained, which is the depth of the channel in the harbor. This will open to the large manufacturing district to be benefited by this wall a deep-sea traffic.

The quay wall was designed by Perry F. Brown, city engineer, and built under the direction of the writer. The Healy Tibbitts Construction Co., of San Francisco, was the contractor.

A Proposed Union of International Associations

By E. L. Gorthell*

Since 1843 there have been held about two thousand meetings of international associations, called assemblies, committees, conferences, congresses or conventions. They have embraced almost every subject in which mankind is interested; from peace to tobacco, from religion to anti-slavery, all the sciences, all branches of commerce and industry, sanitation, medicine, law and economics, all social and financial subjects, etc. A list of these international associations at the present time shows the existence of over five hundred organizations.

At first, and still so to some small extent, these congresses, reunions and conferences were ephemeral—dying at each meeting, resuscitated for a subsequent one, and without a permanent organization or domicile. We have an illustration of this at Chicago in 1893, where 43 international congresses were held during the world's fair; nearly all of these expired on adjournment, although many left important literary products—notably the Engineering Congress, embracing the civil, mechanical, mining, military and naval divisions, which published nine volumes of papers and proceedings.

With international attention to the subjects of these and other congresses persistently growing, it was a logical result that this interest should crystalize into permanent associations, upheld, promoted and subsidized by governments or professions, or by general subscription. After some years, usually the international interest and expansion became so extended that the holding of a congress, which was formerly the only feature, became a part only of a continuous activity in the subject. The congresses are still held in about three or five years (the Navigation Congress is held generally at triennial periods, while the Railway Congress is held at quintennial periods), but the intermediate years are fully occupied, by a permanent committee at some city, Brussels, Berne, Paris, Vienna, London, etc., in publishing the results of congresses, in preparation for them, or in current publications of interest and utility to a membership scattered over the whole world.

It is also a logical result of all of this international activity in the five hundred odd associations now existing that, in order to conduct the work more systematically and properly, there should have been formed a union of all these international associations for coöperation and, it may be said, standardization of congress work.

Brussels was selected as the domicile of this International Union, where the general government fosters, financially supports, and lends its moral and active assistance as well, to many international associations.

The union thus formed has become the exponent, guide and pivot of a large number of permanent international associations; the first world congress of this union was held in Brussels in May, 1910, and to it about a hundred international associations sent delegates. In preparation for this important congress the union published an extended general statement on the usefulness of international associations and a special statement on the various associations, the volume containing these statements embraced nearly 1500 pages. It is a logical result that this union should publish regularly for its affiliates, the various international associations, a journal entitled *La Vie Internationale*, which is the official mouthpiece.

There is to be held the coming year a second world congress of the union, which no doubt will have a much larger attendance and more affiliated associations than in 1910. The congress of 1913 will be held at Ghent, at which place and time will be held an international exposition, which is likely to exceed in size and interest that of 1910 at Brussels. It has been decided to hold the third congress in the United States in 1916. It is therefore of interest to the people of this country now to become acquainted with the objects and appreciate the importance of the union and its world congress.

The questions most in accord with our utilitarian conceptions are naturally, "What are the real practical uses of this congress? What ground does it cover? How does it aid and supplement existing international associations?"

These questions can easily be answered to the general satisfaction of all. At the outset it may be said that it goes afield of pure engineering. But as the engineer of the 20th century is, or ought to be, a man interested in worldwide subjects and one versatile in his aptitudes, actions and interests, the literary exponents of engineering must necessarily go afield of the strict definition of engineering. They must be interested in whatever concerns the welfare of mankind, whether it be in construction of means of transportation and satisfying the commercial wants of man, or in the study of man himself in his multifarious relations, or of the globe he lives on, its geodesy and geology, its relations with other worlds of the universe. They must include the study of man himself, his anatomy, physiology and hygiene, the sanitation of his

*Felsenburg, Bern, Switzerland.

abodes, the cure of his diseases, the means of building up and developing his local, national and international life and relations, which look to peace and prosperity, enlightenment, good government and good laws. The time has come when scientists and practical men of affairs who are interested not only in their professions and businesses, but also in the human race, *per se*, should support a union of all the varied interests of mankind associated until now in separated international associations. A union, which in a business and practical way, seeks to establish coördination, coöperation, harmony in methods and uniformity even to standardizing the rules and regulations that govern all these associations and their recurrent meetings, should be of interest to and be supported by the engineer. One practical feature of great advantage to all international associations is the establishment of a medium for their promotion, by which they can know what each is aiming to do and is accomplishing by itself; thus each can learn from all others what its own defective methods are and can give to all the excellent qualities it possesses above others.

Among the features of the Union of International Congresses most important to the engineering profession are the purpose of and efforts for common international weights and measures, money, universal technical terms, common methods of investigations and uniformity in stating results and, eventually a universal technical language, of which Esperanto is an example, which in the future, when subjected to modifications and improvements which its exponents themselves suggest, may become the world tongue.

Whatever may be the object of an international association, and to be attained by international congresses or meetings from time to time, it will find that in other or perhaps many other associations and their congresses there are many features common to their own; questions also that formerly were discussed in, say, an international engineering congress, are also discussed in an international association for tests of materials, of navigation, of mines, of railways, of sanitation, of universal science, of statistics, applied chemistry, bibliography and documents, scientific and technical language, technical dictionaries, sociology, international geodesy, commercial education, international expositions, aëronautics, archives, libraries, stenography, pedagogy, international economy, architecture, even by the established bureaus of postal union, copyright, telegraphs, international peace, etc.

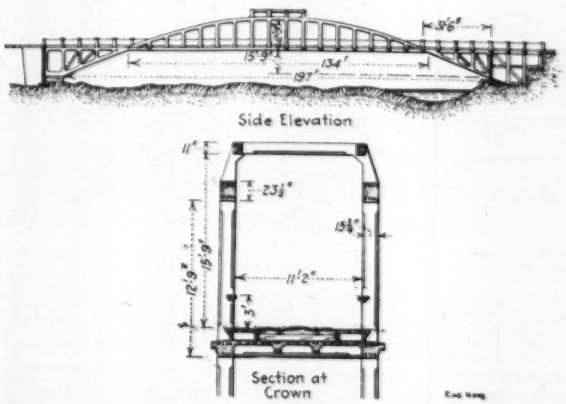
It can easily be seen that a committee might be formed from among the various associations united in the Union of International Associations and meeting annually, might take up special but related unsolved problems and report at the next meeting or congress, or through the monthly periodical of the union, keep the various associations *en rapport* with each other.

At the World Congress of Associations at Brussels in 1910, 132 international associations had become permanent affiliates of the union and met in general discussions of questions of common interest. It was then decided to be necessary to establish a permanent center for all associations. The object appealed to the Carnegie Endowment and it at once accorded an annual subvention of $15,000. This has been increased by dues of members (which are always associations), subsidies of governments and by subscriptions of private interested individuals.

As complementary to the annual meetings and triennial congresses the union has established for its work a permanent executive committee, a universal international library and an international museum, where may be found maps, exhibits of countries, publications, catalogs of all kinds, and a department of archives.

A Light Reinforced-Concrete Arch, La Mescla, France

An extremely light reinforced-concrete arch bridge has recently been completed across the Rivers Vars, in France, on an electric interurban line which runs from Nice to Digne. From articles in the foreign technical press, we have prepared the following brief description. A side elevation and section of the structure appear in the accompanying cut.



REINFORCED-CONCRETE ARCH BRIDGE NEAR LA MESCLA, FRANCE

The bridge has two no-hinged arch ribs, 197 ft. between faces of abutments and with a rise of 28.5 ft. The roadway is carried part way up the arch, as shown in the cut. This roadway, a 3-in. reinforced-concrete floor slab, is carried on two longitudinal fascia stringers, 15¾ in. square, reinforced with seven 1-in. rods, and two track stringers, each 6x10 in. in section and reinforced with four ⅜-in. rods. These stringers frame into 9¾x11¾-in. floor-beams, reinforced with four 1½-in. and two 1¼-in. rods and spaced about 8 ft. center to center. In line with these floor-beams are the vertical posts, which in the middle act as hangers and at the haunches as columns, carrying the roadway. At the haunches it will be noted that these columns are diagonally braced. The posts are 9¾x15¾ in. in section and carry four 1-in. rods. The arch ribs proper are 15¾ in. wide and 23½ in. deep throughout, reinforced with eight 1⅜-in. rods. Wind bracing is provided at the crown in the way of the framed structure shown there on the cut.

The abutments, it will be seen, are also structural members of reinforced concrete, but we are unable to give any further details of them than are shown in the illustration. A 1:1½:3 concrete was used.

The bridge is very similar in design and lightness to the present world's largest reinforced-concrete arch bridge across the Tiber at Rome (ENGINEERING NEWS, Nov. 30, 1911, p. 641), which was built by the same company, the well known European firm of Hennebique.

Boiler Explosions as Affected by Unsymmetrical Riveted Joints

An interesting pamphlet by S. H. Barraclough, A. J. Gibson, H. W. May and E. P. Norman, being a reprint from the 1911 *Proceedings* of the Engineering Association of New South Wales, is at hand, bearing the title given above. In it they relate some studies which were made on two locomotive boilers which had exploded in service, and under conditions which did not permit of the usual explanation, "abnormal conditions." In both cases the fractures were along double-riveted lap seams. In one case the fracture followed the course of the joint in such a manner as to be entirely covered by the protecting lap of the unaffected plate. In the second case the fracture was along the inner line of rivets.

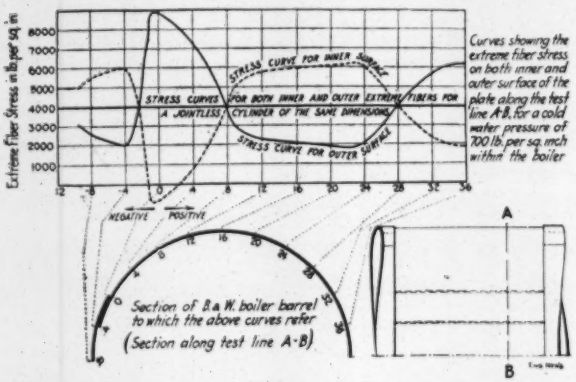

Extreme Fiber Stress in lb. per sq. in.
8000
7000
6000
5000
4000
3000
2000
1000
STRESS CURVE FOR INNER SURFACE
STRESS CURVES FOR BOTH INNER AND OUTER EXTREME FIBERS FOR A JOINTLESS CYLINDER OF THE SAME DIMENSIONS
STRESS CURVE FOR OUTER SURFACE
Curves showing the extreme fiber stress on both inner and outer surface of the plate along the test line A-B, for a cold water pressure of 700 lb. per sq. inch within the boiler
NEGATIVE
POSITIVE
Section of B. & W. boiler barrel to which the above curves refer
(Section along test line A-B)
A
B

FIG. 1. LAP-JOINT STRESSES IN ONE PLATE OF A WATER-TUBE BOILER BARREL

A theoretical study of the stresses involved in such an unsymmetrical joint convinced the authors that, due to the bending moment of a couple introduced by the lap of the plates, the outside fiber stresses might rise to a tension of four times the direct stress on the inner side of the plate, and a compression of twice the direct stress on the outer side of the plate. To these initial stresses from pressure in the boiler would be added the stresses set up by variations of pressure in temperature that accompany normal working operations covered by the term "breathing."

The boiler plate in the first explosion mentioned was removed so that the corresponding joint on the other side of the boiler which did not fail could be studied. It was found that here the plate was fractured from end to end along the joint line and that the fracture had gone through the plate almost to the outer skin. While the plate was nearly severed throughout its entire length, the edges of the fracture were so close together that its surface even under minute examination looked almost as good as new.

In the case of the second boiler, the unaffected joint was examined and it was found that minute cracks had been started in various directions along the rivet holes—which were known to have been punched. The punching of the rivet holes in the joints was taken, therefore, to be the cause of localizing the fracture along the line of rivets rather than along the protecting overlap of the unaffected plates as in the other case (where the holes were drilled).

Later, experimental investigations were carried on with isolated lap joints, boiler drums, and the dished end of boilers, to determine the extreme fiber stresses in the vicinity of unsymmetrical joints. An ingenious arrangement of fixed and swiveled mirrors was used, after the principles of the Marten's mirror extensometer for the direct measurement of the extreme fiber strain. In the case of the isolated joints the modulus of elasticity of the material was known and permitted a close calculation of the actual stresses. In studying the strains in drum joints and dished ends, in place on boilers in service under changing conditions of pressure load, the actual modulus of elasticity could not be experimentally obtained, but had to be assumed at a reasonable figure, giving probable or approximate values for the stresses. In the case of the made-up joints, tension was applied in the usual way by machine. In the case of the drums and dished ends, hydrostatic pressure was employed to give the tension loading.

With the machine-pulled joints the ratio of maximum extreme fiber stress to the value of direct stress (that without eccentric effect of lapping) was found to be 3.9—agreeing with the theoretical deductions. The value of compression ratio was found to be about two, also in agreement.

Tests on pulled joints with "joggled" plates (plates formed to the eccentric shape which common lap joints would assume under load) showed that the stress in the plates of a joggled lap joint did not approach a value more than twice the maximum fiber stress with a direct load. The authors, however, do not recommend "joggling," under all conditions, on account of the increased stresses set up in the already indeterminately stressed rivets, and on account of the variability of workmanship in the bending for "joggling."

The mirror method of making explorations of outer-fiber stress in the case of boilers in service, showed that the value of the stress did not rise to more than twice that of direct loading, but an explanation of this was found. On plotting the values of stresses along a plate away from a joint, a point of inflection was found also in the center of the plate opposite the (staggered) joints of the next longitudinal ring, showing that the practical construction of the boiler tends to stiffen the various parts and to modify the effect of lack of symmetry in the joints.

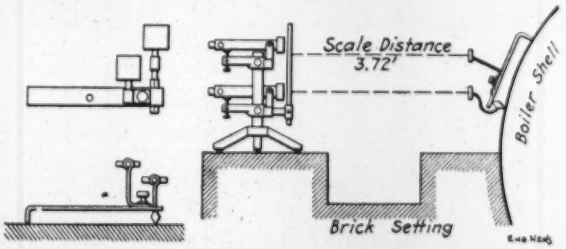


FIG. 2. MODIFICATIONS OF MARTEN'S MIRROR EXTENSOMETER USED IN MEASURING OUTER FIBER STRESSES IN BOILER PLATES

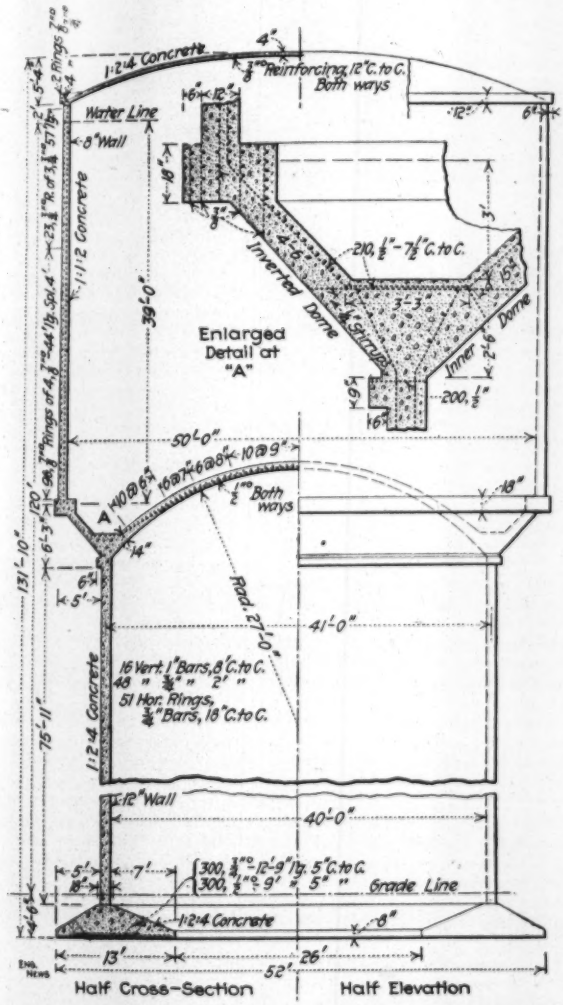
In the author's conclusion it is held that typical lap-joint failures are the result of extreme stress conditions present in this type of joint, and are due to lack of symmetry in design. The warning is given that in the inspection of boilers particular attention should be paid to parts where it is now known that bending actions can occur, and that the examination (with a hand type of stereoscopic microscope) should be most particular for pitting and incipient surface cracks. A further warning

is given that where pitting has been noted its progress should be carefully watched, and should there be a line of pit marks the examination should be even more particular, as hidden cracks often run from one pit hole to another.

A Large Reinforced-Concrete Elevated Tank

By L. J. Mensch*

A very large reinforced-concrete tank was completed by the writer a short time ago at Berlin, Ont., Canada. It forms a part of the new water-works system, the engineers for which are Bowman & Conner, of Berlin and Toronto,



Reinforced-concrete Tank for Water-works at Berlin, Ont.

Canada. This has a capacity of 600,000 U. S. gal., equal to 500,000 imp. gal. The accompanying cut shows the details of the design.

The tank is 50 ft. in diameter inside, with a height of 41 ft., or 39 ft. to the overflow level. It is supported by a reinforced-concrete shell 12 in. thick, 42 ft. outside diameter and about 80 ft. high, resting on a circular foundation 13 ft. wide. The inner and outer domes are proportioned so that the thrusts nearly balance. At the junction of the outer dome and shell of the tank, there exists a great outward thrust from the weight of the shell of the tank and of the roof, which necessitated the placing of a large amount of steel, and in order to secure the coöperation of the steel and the concrete there was provided a section of concrete at this junction of 18x30 in.

The reinforcing of the tank consisted of ⅞-in. and ¾-in. square bars of high-carbon steel, placed in two separate layers where the spacing was less than 4 in. At the junction of the two domes, a great excess of concrete was provided to take care of the thrust of the outer dome while the tank was empty or partially full. The reinforcing of the inner dome consisted of ½-in. rods placed 6 to 8 in. c. to c., which rods were provided to take care of stresses due to the elastic deformation; otherwise the dome is stressed in both directions in compression only, and would not require any reinforcing.

A mixture of concrete of 1:1:2 (or slightly richer) was used in all portions of the tank in direct contact with the water. All other concrete consisted of a 1:2:4 mixture. In order to prevent a leak at the junction of each day's work, due to carelessness in removing laitance or insufficient tamping of new concrete, a dam of No. 28 sheet steel, 6 in. wide, was embedded 3 in. in the concrete at the end of each day's work. These dams came in lengths of 82 ft., which is half the circumference of the tank.

The dome and frustum-shaped bottom shown in the accompanying cuts is an ideal design. Concrete being an ideal building material for compression, is strained to its best advantage in this type. The inner dome is under compression in every direction, and the frustum or inverted dome is in compression in one direction and in tension from water pressure in the other direction. At the junction of the inverted dome and the inner dome, the thrust from these two domes may be balanced by the adoption of proper inclinations and sizes of the domes. Or there may exist a tension in the ring by the thrust of the inner dome being greater than the thrust of the outer dome, or there may exist a compression by the thrust of the outer dome being greater than that of the inner dome. In most cases there is at this point a massive ring of concrete to take care of eventual changing conditions, for the tank empty, for the tank half full, or for the tank filled to its top.

*Contracting Engineer, 138 N. LaSalle St., Chicago.

Coöperative Buying of food supplies is to be undertaken by the New York Railways Co. and the Interborough Rapid Transit Co. for its employees. On Jan. 30, a canvas was made of all the employees on the proposition of having the companies open such stores and the vote was very greatly in favor of the plan.

It is now announced that the car-house at 50th St. and 8th Ave., New York City, will be fitted up for the first store. If the demand warrants extension of the system, other stores will be located at the various distant car-houses or shops. It is planned to carry in these stores all classes of food stuffs not extremely perishable—including table groceries, canned goods, meat, potatoes, turnips, carrots, etc. Approximately 20,000 employees will be in a position to take advantage of this coöperative buying. All sales will be on a cash basis and no accounts of any kind will be carried; this is done in order to reduce the system to the simplest possible basis. There will be no deliveries. Only members of the family of an employee can buy at the stores, for the companies do not intend to enter into competition with existing stores in regular trade. The plan is promulgated to offset in part the high cost of living and to make the employees more contented with employment under these companies.

Modern Road-Making Machinery and Its Use*

By T. R. AGG†

The law establishing the labor system for maintaining the public highways in Illinois was enacted in 1879, and it enumerates the various implements that overseers may require to be furnished as follows: Spade, shovel, ax, hoe, plow, yoke of oxen or team of horses or mules, and a wagon or truck. This indicates about the equipment that was deemed necessary in those days for highway work. There are comparatively few kinds of construction work that are being done today in the manner in which they were done thirty years ago, nor are the same tools being used, and this applies to the processes and machinery used in road construction.

Plant for Earth Roads

There are certain kinds of machinery that have come into use in the construction and maintenance of earth roads, and are used more or less in other forms of road construction. One of the simplest, yet one of the most necessary, is a strong plow of suitable design. It should be sufficiently heavy to permit its being drawn with a tractor, and at the same time should be narrow enough to be drawn with teams when occasion demands. A plow having a long beam with shoes for regulating the depth and with a share not to exceed 10 in. wide will answer most requirements. Soils of a gravelly nature or hard-baked earth can be most readily broken with the "rooter" plow; this should weigh not less than 300 lb., and should have a short beam fitted with a shoe for regulating the depth of plowing.

There are many ways of moving material after it has been loosened, but the slip and wheel scrapers meet all ordinary conditions. For moving earth a distance not exceeding 100 ft., the slip scraper of 5 cu.ft. capacity is best, while the wheeled scraper should be used for distances of 100 to 1000 ft. As a snap team is necessary for economy in any case, it is advisable to use wheeled scrapers of 14 to 16 cu.ft. capacity, and there should be one scraper for each 100 ft. of haul for each gang.

If material is to be moved for general reshaping, a road grader of some kind will be used, and the tendency is to draw this with some sort of a tractor. The grader should be sufficiently strong to withstand the hard service of tractor grading, and it should be arranged with some device for independent steering because it is impossible to steer a heavy tractor with sufficient accuracy to do the proper work with the grader. For crowning up earth roads where much material must be moved, excellent results are being obtained with the elevating grader. It may be of a size to be drawn with a tractor, or it may be smaller and drawn with teams, but the tractor outfit is preferable on good soil. An objection often made to the elevating grader is that it leaves the road rough, due to clods of earth and sod being deposited on the roadway. The grader should not be expected to construct a finished job, but a small amount of subsequent work by a disk harrow and drag will leave the road in excellent condition. The use of steam and gasoline tractors for drawing road machinery, is rapidly becoming general.

The effect of traffic on an earth road is to flatten it and work the soil away from the traveled portion of the road toward the ditches. At least once a year, a little material must be drawn back toward the center of the roadway in order to maintain a proper cross-section. Several devices have been perfected for doing this work. The Monroe leveler is drawn by a tractor which travels in the middle of the road, and the leveler has wings which draw in the material from the side of the road, spreading it in the middle portion. One bad feature is that a ridge of loose earth is usually left in the middle of the road. If a drag and a roller follow the machine this fault is overcome and the road will be so shaped that the traffic will use the middle of the road instead of getting to one side. For light maintenance work, the most satisfactory device is the road-drag, of which a number of types have been developed.

CULVERTS—A large item of expense in ordinary road maintenance, particularly in Mississippi Valley states, is the construction of culverts. These range from 12 to 36 in. in diameter, but the diameters of 12 to 24 in. predominate. Concrete is coming into general use for their construction, and collapsible metal forms are of decided economy. There are a great many types of these forms to be had, but that which will give a circular opening is perhaps to be preferred. The essential principle of all these forms is, of course, that when the concrete has set, the forms can be removed and used for another culvert. Not a few so called collapsible forms fail to collapse when desired and must be left in the culvert. A satisfactory homemade form for circular culverts can be made by building up 2x4-in. scantlings of the desired length around a disk, which has been cut to give a desired diameter to the culvert. The sticks are first strung on a wire run through holes at each end and bored through the 4-in. dimension. The scantlings are then rolled up around the disk and tied with a wire hoop and the wire through the holes removed. The closure is held slightly open by means of wedges, which are removed to permit the collapse of the form. These forms are very cheap and can be used a number of times, and while they do not give as smooth a finish to the inside of the culvert as the metal forms, they may often be used when it would hardly pay to purchase more expensive forms.

A concrete mixer, having a capacity of 3 or 4 cu.ft. per batch, is of advantage in small culvert work. While the continuous mixers in many cases are excellent machines, yet with the unskilled operation usual in road work it is believed that much better results in the long run will be obtained by the use of the batch mixer, and probably this principle holds true on even larger work.

Plant for Macadam Roads

In the construction of hard roads, the material is usually shipped in cars and hauled by wagon to the work. There is on the market a chute which is suspended from the side of the car and is large enough to hold a wagon load of material. The wagon is driven under the chute and the contents are dumped into it by tripping the door, thus securing a wagon load in a very short time. These chutes are of considerable economy where large quantities of material are being handled. The cost of shoveling material into the chutes is less than for shoveling into the wagon, because the opening into which the material is thrown is visible from any position in the car. The great economy in their use, however, is due to the fact that the team is not idle for any considerable length of time while the wagon is being loaded at the car.

It often times happens that the material is shipped and stored during the winter, and with the difficulty of securing cars during the construction season, this practice is becoming more general. When loading such material onto the wagons, a loading incline is essential. This consists of an inclined trough so arranged that the wagon can be drawn up under an apron at the upper end and the crushed stone or other material dragged up by means of a team and slip scraper and dumped into the wagons. While the cost of operation of such a loading device per cubic yard is about as great as the cost of shoveling the material into the wagon, yet the time of loading is much reduced, and there is a saving on the time of the teams. In some instances, the material is quarried and crushed near the site of the road. The machinery required includes a stone crusher of the desired capacity, a gasoline or steam engine for operating the crusher, and a screening plant and bins. The details of the arrangement of the machinery depend upon the class of work being done, but it is common to use a plant having a capacity of 75 to 100 tons of material in 10 hours, together with the necessary screens and bins. In two or three plants of about this capacity in Illinois, the cost of the crushed stone on wagons was 60c. per ton. This included all the cost of quarrying and crushing. The stone being rather a soft limestone and badly fissured in the ledge, the expense for blasting was small.

A macadam road should always be built with a roller. The accepted form for highway or street work is a three-wheel, self-propelled roller weighing from 10 to 12 tons. This is also suitable for rolling embankments in heavy grading work, although the weight might need to be varied with different classes of material to be compacted. If the roller is to be used on bituminous macadam work, it should be equipped with an apparatus for spraying water on the wheels. The weight should be so distributed between the front and rear rolls, that the weight per lin.in. on the front roll is not less than 75% nor more than 90% of the weight per inch of width on the rear roll. The machine should be hand-steered unless the weight is greater than 12 tons, and if mechanically steered, the steering apparatus should be independent of the man operating the roller. Steam, gasoline and oil motor rollers are being used and are giving satisfactory results, and there are classes of work and conditions under which each is most economical.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago, Jan. 22-24.

†Assistant Engineer, Illinois State Highway Commission, Springfield, Ill.

In the construction of waterbound-macadam or bituminous-macadam roads with a bonded lower course, a sprinkling wagon is a necessity. Any type of street sprinkling cart is adapted for this service, but should have 6-in. tires and the "race track" type of gear, that is, the tread of the front wheels narrower than the tread of the rear wheels, so that in effect, the wagon when drawn along the road has a surface bearing of 12 in. on each track. This is necessary, because the sprinkling wagon is used on the macadam at the time when it is in condition to be easily injured, and if the tires are narrow, serious damage will result. The spraying apparatus should be designed to throw the water directly down on the road surface, because the object of the sprinkler is to wash in the screenings and bonding material. The cart should have a pump for taking water from wells or ponds and should be equipped to force water into the steam-roller boiler for washing out.

In preparing macadam for rolling, excellent results are obtained by harrowing the stone after it is spread and just before rolling begins. The harrow should be heavily built, with teeth 1 or 1¼ in. in diameter, and the entire harrow should have a weight equal to about 10 lb. for each tooth. It should be so designed that when drawn the teeth will not follow each other, but will be well distributed across the width of the harrow. If a macadam outfit is doing any maintenance work, a scarafier is a necessary addition. This must have sufficient weight to insure that the picks will be held down into the surface which is being loosened, the picks must be susceptible of adjustment so that the surface may be loosened to any desired depth, it must be so arranged that there can by some variation in the width which is scarafied in one trip, and it should be arranged so that it can be steered independently of the movement of the tractor.

A complete macadam outfit then should contain the following tools: Roller, sprinkling wagon, plow, harrow, tool box, rooter plow, and the necessary small tools. Such an outfit will cost approximately $3100. Records kept in the work of the Illinois Highway Commission for six years and embracing 52 outfit seasons of operations, show that the average cost per outfit per season for maintenance is $61. This includes all repairs and replacement on all parts of the equipment mentioned above.

If materials for road construction are hauled long distances, a traction-engine outfit is necessary for economical work. The choice between the gasoline or oil tractor and the steam engine will depend very largely on the condition under which the machinery is to be operated. In general, it seems possible that there are decided advantages in the use of the gasoline tractor for this purpose. The cars which are used for hauling the material should be reversible so that it is unnecessary to turn the train around at the end of the trip. They should be of the dump-bottom type and arranged so that the load can be spread as dumped. The size of the unit should be such that the load including the wagon will not exceed 5 or 6 tons if the hauling is over roads similar to those in the state of Illinois. For the car of this weight, the wheels should be at least 8 in. broad and should be cambered to fit the crown of a finished road.

Experience in Illinois shows that hauling with such an outfit is cheaper than team hauling for the same distances, and that the economy increases with the length of the haul up to the maximum for which data have been obtained in the work of the commission. The cost per cubic yard for hauling crushed stone with the tractor outfit is about 60% that of team hauling for one mile, and about 40% for distances of three miles. This includes the pay of the operator for the engine (who is paid straight time regardless of the conditions of the weather and whether the job is running or not), the cost of the fireman (who is paid only for the days when the outfit works), the cost of fuel, oil and supplies for the steam engine, and the cost of maintenance. During the average season in Illinois from May 1 to Dec. 1, a tractor outfit can be used for hauling over earth roads only about 50% of the time. A hauling outfit costs approximately $4000, and in the work of the Commission, the cost of maintenance has been $100 per season.

Plant for Bituminous-macadam Paving

If an outfit of road-making machinery is to be used in the construction of bituminous macadam roads by the penetration method, in addition to the machinery already enumerated, there will also be required the machinery for spreading the bituminous compound on the road. The spreading may be done by hand-spreading cans, in which case there are two general types available. In one type, the slot through which the compound is poured is vertical; in the other, it is horizontal. There is a decided difference in the method of handling these two types of cans in pouring the compound, and experience indicates that the former permits more even distribution. Both types are made with arrangements for varying the width of the slot. This, however, is not a very important feature, because the operator will govern the quantity of the material spread very largely by judgment.

If the bituminous compound is to be spread by means of a distributing wagon, there are two general types available: The gravity distributing wagon, and the pressure distributing wagon. The former is suitable for a limited range of operation, and it can be used satisfactorily for spreading light oils for dust laying and similar work where a slight variation of bunching of the material as it leaves the machine is immaterial. For high-class bituminous macadam constructed by the penetration method, the gravity wagon does not give satisfactory results.

Of the pressure distributing wagons, there are two types. One (which may or may not be equipped with a heating apparatus) is designed so that the pressure in the wagon forces out the binder through a hose and nozzle and thus distributes it on the road surface. This seems to give very satisfactory results for certain class of binders, but not with viscons binders or those requiring high temperature for application. If solid asphaltic or tar binders are being distributed, the spray type of wagon is essential. These are of two general classes. One is arranged with a series of nozzles close to the road surface through which the bituminous material is forced by means of pressure produced by an auxiliary pump. A strip of roadway, the width of the spray apparatus, is covered at each trip with this machine. In the other type of machine (used by the Illinois Highway Commission), the binder is applied by means of a nozzle, which is carried by an operator walking behind the machine. The air pressure in the tank forces the material through the nozzle and a jet of steam forced into the binder at the orifice in the nozzle breaks the binder into fine spray.

In addition to the distributing wagon or cans for distributing the binder, there will also be needed tanks for heating the asphaltic binder. Some of the distributing wagons are fitted with heaters, but in general open-top heating kettles into which large pieces of solid binder can be placed are also needed. Along with these tanks, there will be required a certain amount of small apparatus such as asphalt cutters and various small tools. The cost of a bituminous outfit is $1000. Data collected upon 12 seasons of operation show that the cost of maintenance per outfit per season is $106.

Plant for Concrete Roads

The construction of concrete roads requires a complete outfit of machinery. There will be a steam or gasoline roller weighing about ten tons, and certain special machinery for the concrete. The mixer should be of the batch type and should load from in front and discharge from the rear. It should be self-propelled and for this class of work, experience shows that the steam-driven machine is more satisfactory than the gasoline machine. In country road work it will be found that the water-supply will require special attention. The water will be obtained from ponds, reservoirs or wells, and must be pumped to the mixer. This will necessitate a pumping outfit and a system of piping arranged alongside the road so that the hose from the mixer can be attached at any place. The pumping outfit should be of ample capacity, certainly capable of delivering three or four times the amount ordinarily required by the mixer itself, because in hot weather a large amount of water is necessary for wetting down the subgrade before the concrete is placed and for sprinkling the concrete behind the mixer.

In addition to the concrete apparatus, there will be required templets for striking the road surface. These usually consist of two 1-in., or 1¼-in. boards cut to the desired crown for the road and fastened to blocks parallel to each other and about 6 in. apart. They are drawn along the top of the forms at the edge of the concrete. For floating the surface after it has been struck off to the desired crown, a float made of a thin board of sufficient length to reach the entire width of the pavement and one foot on each side is bent to the crown of the finished pavement and held by means of ribs to which it is attached. This float is drawn with a combined forward and crosswise movement in such a way as to float the finished concrete and at the same time strike it down to the desired shape. There will also be required the ordinary tools used in concrete work, that is, wheelbarrows, shovels, picks, tampers and similar tools.

The cost of a complete concrete road outfit can be made anything desired, but the essentials for placing the concrete and furnishing the water-supply, including a mixer having a capacity of about 1000 sq.yd. of 6-in. pavement per day, with all auxiliary apparatus and tools, will cost about $2700.

The Panama Pacific International Exposition

By J. H. G. Wolf*

The opening of the Panama Canal, announced to be ready for traffic during the Fall months of the present year, is exacting more interest and attention generally than any event of political or social importance in years. That it will have a revolutionary effect upon certain lines of trade, and upon the welfare of certain countries fortunately situated with respect to particular trade routes, is confidently expected. The belief that such things will be realized in the case of California and the two other western states bordering upon the Pacific led, some years ago, to projecting a celebration in the form of an exposition to be held at San Francisco in 1915, the construction work on which is now under way.

The accompanying figure shows (1) the position of the site beside the Golden Gate and (2) a simplified plan of the exposition buildings and grounds.

The lines of development of the project have followed in a way past expositions, but have been varied here to take advantage of the site upon the Golden Gate Channel and to include developments of arts and sciences in the past decade having exhibition possibilities. There are the usual exhibition palaces, some 14 in number, designed to surround and flank a central court; there is a group of amusement concessions, in which it is aimed to furnish only the highest class of diversions; there are to be separate buildings for the Federal Government and the several states, and for foreign governments. There will also be aviation and drill fields and grounds for stock exhibits, etc.

Prominent architects and landscape engineers, particularly those who have had experience with past expositions, have worked as an architectural commission in collaboration with local talent and a staff of colorists, sculptors and artists for two years or more developing the main plans. The general status of the enterprise can be summarized by noting the following progress, as of Jan. 1, 1913:

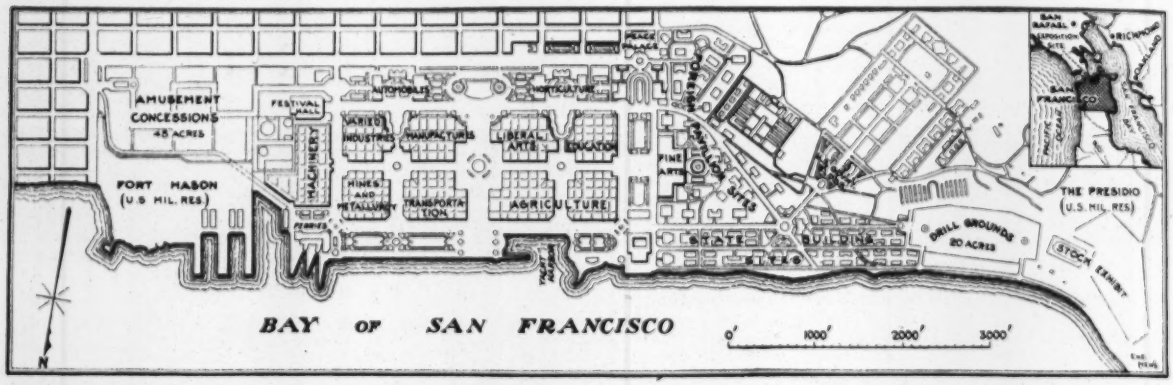
(1) The site, 1.6 miles long and 0.5 mile wide, has been practically cleared, and the lowlands covering a part of the area have been filled with sand dredged from the bay; some seawalls have been built and others are under way.

(2) The Service Building, which will contain the administration, construction and police departments, the first building upon the grounds, is about completed.

(3) Ground has been broken for Machinery Hall, which is to cover some eight acres and will be the first exhibition palace. It is to cost $600,000 and the contract has been let. The remaining exhibition palaces are all to be placed under contract during the present year, and all are to be finished by June, 1914, or *eight months before the opening* of the exposition (February, 1915).

(4) The matters covering the distinctly civil-engineering works—the docks and sewers, the gas, water and electric mains, the roads and streets, have been entrusted to a corps in the Division of Works. Plans covering these features are about completed and construction of the sewers is already under way. Bids are about to be advertised for 10 miles of special high-pressure water mains for fire protection (in connection with the harbor fire boats) and 20 miles of water mains for ordinary domestic service.

(5) Within 10 months after President Taft's invitation to foreign nations to participate, 27 governments signified their intention to exhibit and, of these, six (the first enumerated) have already selected sites for their buildings. The nations are:



1. Japan,
2. China,
3. Sweden,
4. Portugal,
5. Canada,
6. Holland,
7. Guatemala,
8. Haiti,
9. Salvador,
10. Santa Domingo,
11. Honduras,
12. Mexico,
13. Panama,
14. Costa Rica,
15. Peru,
16. Bolivia,
17. Ecuador,
18. Uruguay,
19. Chile,
20. Liberia,
21. Nicaragua,
22. Cuba,
23. Brazil,
24. France,
25. Great Britain,
26. Germany,
27. Spain,

The following 35 states and territories have prepared to participate, of which the first 23 are said to have selected sites for buildings:

1. New York,
2. Pennsylvania,
3. Nebraska,
4. Arizona,
5. Illinois,
6. Ohio,
7. Utah,
8. Washington,
9. Oregon,
10. New Jersey,
11. Colorado,
12. South Dakota,
13. Nevada,
14. Missouri,
15. Idaho
16. Kentucky,
17. Montana,
18. West Virginia,
19. Indiana,
20. Hawaii,
21. Minnesota,
22. Philippines,
23. California,
24. Georgia,
25. Iowa,
26. Kansas,
27. Kentucky,
28. Louisiana,
29. Maryland,
30. Massachusetts,
31. New Mexico,
32. North Dakota,
33. Texas,
34. Oklahoma,
35. South Carolina.

(6) Applications for exhibition space are reported to amount to 2,000,000 sq.ft., and to have come from all parts of the world; applications for amusement concessions requiring the expenditure of several millions of dollars are filed, and it is probable that those accepted will run towards the reproduction of natural wonders, such as the Grand Cañon, the Panama Canal, and various objects of distinct historical interest and educational value.

San Francisco, while still staggering under the 1906 loss of a half billion dollars in property or business interests, is fulfilling the trust imposed by Congress. The

*1023 Mills Building, San Francisco, Calif.

citizens have subscribed (and are duly paying) $7,500,000; the city and the state have each bonded for $5,000,000, making in all a base fund of $17,500,000. To this must be added the expenditures of each of the 58 states and foreign governments for their individual exhibits (varying in amounts from $10,000 to $1,000,000, the announced intended expenditure of Japan).

The business organization of the fair is founded upon an incorporated company, called the Panama Pacific International Exposition Co., capitalized at $5,000,000, and governed by a board of directors of 50 prominent local men assisted by special city and state commissions. The members of the directors' executive committee and the controller constitute the cabinet of the president, which practically directs all affairs. The executive staff of the president consists of a director-in-chief, a director of exploitation, a director of works and a director of concessions and admissions. The president of the corporation, the man whose ability has contributed most to the present degree of success, is a well known engineer, Charles C. Moore.

Oregon State Irrigation Congress

[CONTRIBUTED]

The second annual Oregon State Irrigation Congress, which was recently held in Portland, Ore., was notable for the good attendance of practical irrigators, real farmers and experienced engineers.

The opening speech was by Jos. N. Teal, whose efforts in the line of conservation have been recognized throughout the United States. The report prepared by the State Conservation Commission, largely under his personal direction, is one of the most noteworthy documents of its kind.

Mr. Teal spoke of the necessity of coöperation between the state and federal government in future irrigation work, particularly on the larger projects. He also described the great opportunities in connection with the development of the Deschutes River, and outlined a tentative agreement that is being made with Secretary of the Interior Fisher in the matter of investigations on the Deschutes River.

The discussions at this conference were participated in by men of moderation and of sound sense. The control of the meeting was evidently in their hands, a condition so unlike that of many of the so called irrigation congresses elsewhere, that there has been general comment on it.

Practically all of the recent irrigation enterprises whose securities have been offered to Eastern purchasers have been financial failures largely due to the fact that the prime object of their organization was to secure the promoter's profits and a commission frequently as high as 20% on the sale of the securities. Many of them which possessed merit have failed because of the fact, which is now being generally appreciated, that it takes a long time to develop agriculture in a new country, and the interest charges and costs of operation and maintenance during this long time amount to a sum which not only takes away the profits, but eats into the principal.

With all of the relatively easy irrigation projects taken up, there appears to be very little outlook for future construction, excepting under some form of coöperation between the state and nation, or under the terms of the federal Reclamation Act.

There are millions of acres of arid land now reclaimed at large cost which are lying untilled. The owners or entrymen who control these do not have the capital or energy to utilize them or are hoping to sell out at large prices to homeseekers from the East. The lure to the Eastern man is cheap land, and with the prices asked, he cannot see where his profit comes in. Thus, there are few, if any, land sales being made to newcomers.

It is refreshing to find that the substantial men of the West are appreciating these facts. They know that the inflation of prices has been an injury to them and that they must cut down to bedrock and be prepared to share with the newcomer the benefits of increase in land values which are due to cultivation of the soil. It is seen to be not only fair, but also a matter of sound business sense, to admit freely the risks of irrigation investment, and the worthlessness of many of the existing irrigation stocks and bonds. It is also acknowledged to be unwise to permit the homeseeker to assume that irrigation is an easy way of acquiring wealth. He should be clearly informed of its difficulties and risks; that it is pioneering; that a large portion of the soil is liable to deteriorate under careless handling and that from 15% to 30% of the best lands have been ruined under existing systems by swamping or alkali; that plant and insect pests are liable to attack his crops, and that markets cannot be had at first for all of his produce. In other words, that he is taking a large risk and should be reasonably sure of the opportunity of correspondingly large profits.

At the same time it should be clearly shown that with the exercise of skill and good judgment, accompanied by reasonably hard work and self-denial, the rewards should be correspondingly great, and that the same amount of energy which is applied in other enterprises, accompanied by reasonably good fortune, will result in the majority of men obtaining a competence beyond their reasonable expectation elsewhere.

When other state and national conventions in the West get down to business on a foundation of this kind, it is believed that substantial and steady progress will result.

The Coal Production of Canada for the year 1911, is reported in a bulletin just published by the Department of Mines. From this it appears that 11,323,338 short tons were put out, compared with 12,909,155 tons in 1910, a falling off of about 12% due to labor troubles in Southern Alberta and Eastern British Columbia. The approximate selling value of the coal at the mines in 1911 was $2.34 per ton, compared with an average of $2.39 per ton in 1910. Nova Scotia in this year produced 62% of the total; British Columbia, 22%; Alberta, 13%, and Saskatchewan less than 2%. Of the total production, 75.6% was sold for consumption in Canada, 9.4% for export to the United States and 2.5% for export to other countries, with 3.4% used by colliery operators making coke and 9.19% used for colliery purposes and by workmen.

The Transit a Rival of the Hat Pin—The following letter appeared in the New York "Times," Jan. 28, 1912:

To the Editor of the New York "Times":

Cannot something be done to make surveyors cover the points of their tripods while they are carrying them on their shoulders? They invariably carry them on their shoulders with the points extending the full length of the legs in front of them.

The other day in walking down Broadway, while the sun was shining into the eyes of persons going south, on three separate and distinct occasions, within a distance of two blocks, I narrowly missed having my head punctured by surveyors going north with the points of the tripods exposed, as stated above.

The above danger to pedestrians can be obviated by the use of a leather cover for the points, as used by traveling photographers.

EDWARD SCHWAB.

International Cement Questions from a French Viewpoint

The wide differences existing between the cement experts and engineers of different countries were brought into sharp view at the Sixth Congress of the International Association for Testing Materials, held in New York last September. This was apparent in our report on the congress (see ENGINEERING NEWS, Sept. 12 and 19, 1912, pp. 502 and 513); by reference to that report it will be seen that the antagonism is chiefly between Germany and all other countries.

The situation is further illuminated in an account by the noted French cement man, R. Feret, given last October in an address before the Réunion des Membres Francais et Belges de l'Association Internationale pour l'Essai des Matériaux, at Paris, France. From a copy of the proceedings of the Réunion we quote some parts of this account in the following:

Mr. Candlot's proposal to eliminate the clauses of certain specifications which require an increase of strength from 7 to 28 days was lengthily discussed, although it is of interest only in a theoretic way to a certain number of foreign members, there being few specifications which require such increase of resistance. Nevertheless the meeting decided in favor of a committee for studying this question.

Then was discussed a communication of Mr. Poulsen, a Danish engineer, who at the Copenhagen congress had already presented an important paper on the behavior of cement in sea water and on puzzolanic additions. On the first occasion he dealt with researches on a special puzzolana, a diatomaceous earth known in Denmark as "moler." The paper concluded that it is useful to add this material (pulverized and dried) to cement, particularly in the case of work in sea water.

The subject was discussed at length, and the question of puzzolanic additions was treated broadly. In particular, recourse was again had to the argument, oft-repeatd but long ago refuted, that puzzolanic additions improve mortar only by mechanical action, through the effect of greater fineness of their particles, which fill up the interstices and render the mortar more compact. I have demonstrated repeatedly that if a particular cement has added to it in one case a fine puzzolanic material, in another case an inert sand pulverized to the same fineness, the former mixture is much superior to the latter, and in fact the latter is inferior to the original cement. The communication of Mr. Poulsen brought forward no proposition for a resolution, and the discussion remained platonic [sic].

In the second session the question of accelerated tests for constancy of volume of cement was first taken up. At prior reunions I have made reference to the existing differences on this subject, and you well know what animosity the German manufacturers have exhibited toward the Le Chatelier test; accordingly all of them came to New York with the fixed resolution to rescind the vote of the Copenhagen congress which recommended officially the Le Chatelier method as the normal accelerated test of constancy of volume.

On account of the well pronounced diversity of opinion there were numerous papers on this subject. The discussion could not be called lively, for the method fixed by the rules prevented all animosity; but it was long, and many speakers set forth their views on the subject. Most of them were Germans, and their arguments in all cases rested on the two same sets of experiments—that of ten cements which had not shown up well in various accelerated tests and yet during 16 years have behaved quite well under weather exposure; and the more recent experiment on several cements which, subjected to the Le Chatelier test in various laboratories, gave discordant results. I think it unnecessary to recall to you the refutation of these arguments, and the test results cited by the advocates of the Le Chatelier test.

Besides identical resolutions proposed by Mr. Gary and Mr. Martens, Mr. Robertson presented one asking simply for the nomination of a committee to continue the study of the question. For my part, in view of the first portion of the German proposal [calling for the revocation of the Copenhagen resolution as a preliminary to referring the question to a new committee for study.—Ed.], I considered the phrasing of Mr. Robertson inadequate, and demanded the adoption of a resolution which, while recognizing the necessity of new study to perfect the test method adopted by the Copenhagen congress, should explicitly state that the New York congress could not logically (unless it had new, contradictory test results) go back on a decision taken by a former congress as the result of long study by an international commission. This view was fully aired in a session of the council, which agreed with it unanimously, Mr. Martens included. Thereafter, in the session of the committee on resolutions, Mr. Gary abandoned the first part of his proposition, and I no longer had reason to maintain my motion. Therefore the committee was able to agree without great difficulty on a resolution which was subsequently adopted without comment by the session and by the full congress [practically the Robertson resolution.—Ed.].

After this long discussion the session took up the no less important problem brought forward by Mr. Müller in the name of the Association of German Manufacturers of Portland Cement, who requested the International Association to fix a maximum sulphuric-acid content for portland cement. Like a certain number of prior publications on the same subject, the report was based on a test made in Germany with two samples of cement, one German and the other French, used partly in natural condition, partly after adding gypsum in such proportion that the sulphuric-acid content was raised to 2½%. The examination of mortar immersed in sea water was claimed to be entirely in favor of the first cement, although this in its natural condition contained a sulphuric-acid percentage considerably higher than the second.

To these claims it was objected that it would be unsafe to base a conclusion on a single experiment, in which, moreover, the two products under comparison were profoundly unlike in other points (notably in fineness of grinding and in alumina content), which rather than the sulphuric-acid content might have been the principal reasons for the reported difference of behavior in sea water. For my part, while recognizing the great value of further researches, I considered it necessary to move the previous question by observing that the International Association should limit its activities to the standardization of test methods, an object in most cases involving sufficient difficulties, and to leave to every user the selection of specification figures.

This view, it appears, raised a very lively and extended discussion in the council. It was recognized that substantially this principle had been established since the beginnings of the Association, but that it had been partly abandoned later on in connection with certain questions relating to specifications for metals. To reaffirm the principle at the present time, even though in another line of tests, would tend to overthrow what had been built up by great labor. Facing this difficulty, I did not insist on my motion, and on the other hand the original motion also was dropped by its promoters; thereupon the resolutions committee had no difficulty in agreeing upon a motion [for appointing a committee to study the subject.—Ed.].

This is a very interesting matter for study, and its final settlement may entrain important consequences for practice. This can be seen if it is remembered that the present adoption of the proposition of the German manufacturers would have had the result of opening to their product certain markets, such as those of South America, from which they are excluded at present by excessive sulphuric-acid content. This discussion furnishes one of many counterarguments opposing certain scoffers who see in our congresses only pretexts for promenading and receptions, but no practical value.

The report of Mr. Schüle, chairman of committee 42, on uniform tests of hydraulic cement by prisms, and standard sand, gave an account of the work of this committee and sketched the state of the plastic-mortar question, without proposing a definite test method, the subject being not yet wholly cleared up. He indicated, however, some points on which the members of the committee were able to agree. The related question of standard sands came up, though this can hardly be settled until after the test method itself shall have been fixed. In the meantime it is agreed that different laboratories will compare the standard sand of each country with the German standard sand, which up to now is the only one produced regularly and under careful inspection.

In a communication on this subject Mr. Gary attacked the principle of plastic mortar, quoting test results showing considerable divergences arising through its use. However, Mr. Gary does not rigidly oppose a study of the question. He merely states that in Germany, tamped mortar gives complete satisfaction, so that no interest is taken in other methods. Mr. Schüle objected that the German operators perhaps had not the required amount of skill in mixing plastic mortar, which would account for the variable results.

There followed a discussion in which various special points of the subject were treated, for example the question of

whether it is desirable in figuring averages to reject the lowest observations. But as all were agreed that the tests should be continued the debate was not very animated, and the meeting adopted Mr. Schüle's motion [calling for continuation of the work of the committee and application of the method to the comparison of different standard spans.—Ed.].

It is to be remarked only that a German, Mr. Probst, declared himself an advocate of tests with plastic mortar, which aroused the protest of his countrymen.

Progress of the Commission Plan of City Government in 1912

The commission plan of city government was adopted by some sixty or more cities in 1912, compared with nearly a hundred the previous year. We give herewith a list of 63 cities which adopted the plan in 1912, as recorded by Clinton Rogers Woodruff, Secretary of the National Municipal League, Philadelphia, Penn. The list is followed by comments upon it from another reliable source and from a somewhat different viewpoint, after which there is given a summary of the progress of the commission plan from its adoption by Galveston, Tex., in 1901, to the close of the past year. It should be noted that all our figures are based on years of adoption and not the dates the plan went into effect.

LIST OF 63 CITIES REPORTED AS HAVING ADOPTED THE COMMISSION PLAN IN 1912

New England	1
Salem, Mass.	43,697
Middle Atlantic	7
Atlantic City, N. J.	46,150
Deal Beach, N. J.	273
Long Branch, N. J.	13,298
Longport, N. J.	118
Nutley, N. J.	6,009
Ridgefield Park, N. J.	966
Wildwood, N. J.	898
South Atlantic	3
Florence, S. C.	7,057
Sumter, S. C. (City Manager)	8,109
Tampa, Fla. (Advisory vote)	37,782
South Central	12
Sheffield, Ala.	4,865
Charleston, Miss.	1,834
Gulfport, Miss.	6,386
Jackson, Miss.	21,262
Meridian, Miss.	23,285
Hammond, La.	2,942
*New Iberia, La.	7,499
Natchitoches, La.	2,532
New Orleans, La.	339,075
Lebanon, Tenn.	3,659
Covington, Ky.	53,270
Lexington, Ky.	35,099
North Central	8
*St. Joseph, Mich.	5,936
Harvey, Ill.	7,227
Marseilles, Ill.	3,291
Portage, Wis.	5,440
Janesville, Wis.	13,894
Menominee, Wis.	5,036
Rice Lake, Wis.	3,968
Superior, Wis.	40,384
Northeastern	16
Ottumwa, Ia.	22,012
Duluth, Minn.	78,466
St. Paul, Minn.	214,744
Tower, Minn.	1,111
Arkansas City, Kan.	7,508
Great Bend, Kan.	4,622
Holton, Kan.	2,842
Junction City, Kan.	5,598
Manhattan, Kan.	5,722
Olathe, Kan.	3,272
Parsons, Kan.	12,463
Lincoln, Neb.	43,973
Nebraska City, Neb.	5,488
Madison, S. D.	3,137
*Watertown, S. D.	7,010
Polson, Mont.	not given
Southwestern	10
Bishop, Tex.	not given
Franklin, Tex.	not given
Frankston, Tex.	not given
McKinney, Tex.	4,714
Willis, Tex.	not given
Ada, Okla.	4,349
Collinsville, Okla.	1,324
Okmulgee, Okla.	4,176
Colorado City, Colo.	4,333
Durango, Colo.	4,686
Pacific	6
Everett, Wash.	24,814
Pasadena, Calif.	30,291
*San Bernardino, Calif.	12,779
San Mateo, Calif.	4,384
*Phoenix, Ariz.	11,134
Boise, Ida.	17,358

*See two paragraphs following this table.

A list of commission-governed cities is kept by The National Short Ballot Organization, which also collects the charters and organic laws under which cities are empowered to adopt the commission plan. The Organization has a standard for judging whether or not it shall include cities in its loose leaf "Digest of Short Ballot Charters."

H. S. Gibertson, assistant secretary of the Organization, has kindly sent us the following comments on the National Municipal League list:

Checking up your list, I would make the following comments: I am not informed as to the cities under 2000 population, since we do not consider cities of less size worth recording. Aside from this, I should question New Iberia, La.; St. Joseph, Mich.; Watertown, S. D.; San Bernardino, Calif., and Phœnix, Ariz. San Bernardino must be a mistake. As to Phœnix, Ariz., I know that they did adopt the commission plan of government, but the Governor refused to approve the charter on the ground that it was unconstitutional. They will have to draft an entirely new document before they can change their form of government.

A list of 206 cities, reported as having adopted the commission plan up to Dec. 31, 1911, was published in our issue of Apr. 4, 1912, p. 638. The reported adoptions by years are as follows: 1901, 1; 1905, 1; 1907, 9; 1908, 6; 1909, 29; 1910, 58; 1911, 95; 1912, 63. Doubtless the list is subject to corrections, but as it stands the total adoptions to date are 269. Although the accessions in 1912 were fewer than in 1911, they included New Orleans and St. Paul, with populations in 1910 of 339,075 and 214,744, respectively, each larger than any city which had previously adopted the plan. Altogether, eight cities of more than 100,000 population in 1910, and several which had nearly that then and probably equal or exceed it now, have adopted commission government.

A number of other large cities, including Boston, Pittsburgh, Los Angeles and Seattle, have one of the chief features of the commission plan, a small single-chambered city council, but these cities retain their mayor and also maintain a separation of executive and legislative functions.

Increasing the Service of Freight Cars*

By J. M. Daly†

The average movement for all freight cars on the Illinois Central R.R. in the busy season is 27 miles per day. This is equal to three hours moving in trains and 21 hours standing on sidings or 87% of the time on sidings and only 13% in movement.

The average time consumed by the shipper in loading cars is less than two days, and the average time consumed by the consignee in unloading is less than three days, Sundays included. The average number of loaded trips per car per month is 2.7, an average of 11 days being required to handle each load. This includes all cars, revenue and company freight cars loaded on our rails and loaded cars received for other roads. The car, in a busy season, averages per month as follows: 13 days loading and unloading; 3½ days moving in trains; 13½ days standing waiting movement, switching or repairs; total, 30 days.

If we could increase the daily average mileage from 27 to 35 miles per day, it would result in 183,960,000 increased miles with our present equipment. This divided by 27 miles per day is equal to one car 6,813,333 days at 45c. per day, or a saving of $3,065,999 in per diem paid for use of foreign cars. It is squal to the service or purchase of 18,666 additional cars. To this must be added the increased revenue that would be derived from the increased use of equipment.

I am dealing with the present methods employed and the lack of proper supervision obtained over the location, movement and use of equipment. We have approximately 65,000 freight cars on our road. Take all the reports furnished, and total cars reported are about 45,000 leaving 20,000 (or 30%) unaccounted for. The failure on the part of agents, yardmasters and others to account for so many cars each day forces the conclusion that most of them have been overlooked.

As 87% of the freight equipment on our line is standing at stations, yards and shops at all times, it devolves upon us to supervise the stations, yards and terminals with a view of expediting the movement of the equipment so delayed. To secure the results in this direction there is only one businesslike method to pursue, and that is to properly organize the terminals and yards so that the men in charge will know of every car they have and why they have it. Instead of knowing merely that they have 6000 cars on the terminal, they should know in detail why all of these cars are there, and what cars should not be there and why they are not moved.

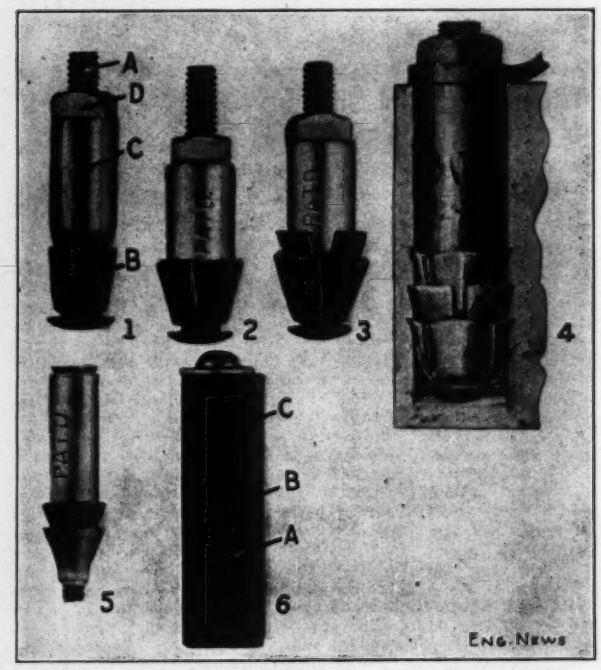
To obtain this result it is necessary to employ sufficient yard clerks to check the tracks assigned them in three or four hours in the morning, and then to devote the balance of the day to analyzing the check made and preparing data for the man in charge of the terminal.

*Abstract of a paper read at the annual meeting of operating officers of the Illinois Central R.R.

†General Superintendent of Transportation, Illinois Central R.R., Chicago.

A New Expansion Bolt

An expansion bolt now being introduced develops a positive hold and a longitudinal strain upon the material in which it is set, instead of depending upon a friction grip developed by expanding a sleeve radially against the wall of the bolt hole. The construction is shown clearly in the accompanying cut. Upon the bolt *A* is slipped a conical die-formed steel cup *B*, which is slit at the sides, so that in expanding it will spread out in the form of flanges. This cup rests on the bolt head, and following it is a sleeve *C* having one end tapered, while above this sleeve is the ordinary nut *D*. The cup and sleeve being in place, as shown at 1, the bolt is dropped into the hole, and the nut turned; the bolt head then faces the tapered end of the sleeve into the cup, thus spreading the latter, as shown at 2, so that its edges cut into the side of the hole. Where extra resistance is required two (or more) cups



A New Form of Expansion Bolt

may be used, as shown at 3. The sleeve may be of any desired length, according to the purpose for which the bolt is used; and where the work is very shallow the cup may be much shorter than is shown in the cut. When a strain is put on the bolt, it is resisted by a direct pull of the cup edges embedded in the material. This is shown by the sectional view, 4, which represents a bolt set in concrete and having three cups expanded.

The cut also shows the same appliance fitted to a screw, the cup in this case being threaded to form a nut. At 5, the device is shown with two cups expanded. The action is indicated by the sectional view at 6, from which it will be seen that as the screw *A* is turned, the expansion cup on nut *B* is drawn up against the tapered end of the sleeve *C*, thus spreading the cup so that its edges bite into the material. As there is no bursting action, the device can be used in thin material without fear of splitting it, the strain being mainly parallel with the pull on the bolt.

The device is made in 23 sizes to suit various sizes of bolts, ($\frac{3}{16}$ in. to $\frac{3}{4}$ in.) and is made in both brass and steel. It is being used for such work as attaching electrical apparatus to switchboards, anchoring lamp posts to sidewalks, and securing chairs to concrete floors in theaters and grand-stands. For the latter work about 70,000 were used at the Polo Grounds in New York and 40,000 at base-ball grounds in Chicago. As the hole may be somewhat larger than the bolt without reducing the holding power of the expansion-cup, a certain amount of play is available in fitting the chairs to the bolts. They have been used also for attaching fixtures to ceilings, where each bolt has to sustain a load of about 500 lb. We are informed by Phillips, Lang & Co., contracting engineers, of Chicago, that they have used the device on bolts for attaching steel frames (for plaster partitions) to concrete bases, for anchoring rails to concrete (without ties), for setting wheel guards and steel door frames in brick walls, and for holding small high-speed motors both on wood sills and concrete foundations. They stated that this was the only expansion bolt which would successfully hold a motor set flat against a concrete wall.

The device is the invention of M. H. Paine, and is manufactured by the Paine Co., 1316 Corn Exchange Bank Building, Chicago. It is sold without bolts, thus saving the cost of freight on the latter.

⁂

Painting Steel Passenger Coaches with baking enamels was noted in a paper reprinted in "Engineering News," Oct. 3, 1912. Since then the Hudson & Manhattan R.R., operating a tunnel system between New York City and points in New Jersey, has found success with baking enamel in repainting its rolling stock. This work is described in the "Electric Railway Journal," Jan. 25, 1913. In this case, since the cars are used almost exclusively in tunnel service, the exterior appearance of the coaches was not considered but the interior finish was desired carefully done.

After cleaning, the car is first heated to 200° with electric heaters strung between the stanchions in the car. The temperature is controlled by a man who watches, through a window, a thermometer inside the car, the current being turned off or on as needed. Windows and doors are closed tight and ventilators are covered with newspapers stuck to the roof with tar. The car is allowed to remain at 200° for one hour to drive off moisture and equalize surface expansion and contraction. The heat is then shut off, the car is cooled down to about 115° and the priming coat applied while the metal is hot. The temperature is again raised to 200° and the enamel baked for three hours. Second and third coats are baked at 140° for three hours, and the last coat for three hours at 130°. All coats except the first one are applied with the air in the car cooled to about 70°. The old enamel is scraped off by hand before painting to remove the bulk of the covering; the surface is then gone over with a standard varnish remover carefully applied so that all the old enamel is removed from the pores of the metal. To clean off traces of the varnish remover, the surface is rubbed with waste soaked in gasoline.

The costs are in general about equal to those of common high-grade painting. The best of materials have to be used, but a given volume of baking enamel covers about twice as much surface as the air-drying variety. The following table shows the cost in detail:

White Work	Material	Labor
Heat at 0.6c. per kw-hr		$3.60
Connecting heaters		1.00
Removing paint from ceiling		7.00
First ceiling coat, 1¼ qt	$1.38	1.25
Sanding same		0.75
Second ceiling coat, 1¼ qt	1.38	1.25
Sanding same		0.60
Third ceiling coat, 2 qt	1.84	1.35
Fourth ceiling coat, 2 qt	1.84	1.35
	$6.44	$18.15
Green Work		
Removing paint from sides		$15.00
First coat green, 2½ qt	$2.30	1.75
Sanding		0.80
Second coat green, 2 qt	1.84	1.80
Sanding		1.50
Third coat green, 4 qt	3.70	1.75
Sanding third coat		0.75
Fourth coat, 2½ qt	2.30	2.00
	$10.14	$25.35

EDITORIALS

The Influence of Dissolved Oxygen on the Corrosion of Metals Immersed in Water

Engineers interested in the corrosion of iron and steel (and this includes a pretty large proportion of the profession) will do well to give careful attention to the contribution by F. N. Speller, which appears on page 294 of this issue. While Mr. Speller's contribution is primarily of interest to engineers responsible for the design of hot-water-supply systems, the data which it contains ought to be generally known and understood by engineers in many different lines of work.

The facts cited by Mr. Speller appear to abundantly demonstrate that the most active agent in causing the corrosion of iron or steel immersed in water is the air and other gases which are contained in solution in the water. It is quite generally understood by engineers that water containing a large amount of carbonic acid gas in solution is apt to cause an abnormal amount of corrosion, but it has been frequently supposed that this was because water charged with this gas became a weak acid. Mr. Speller makes it clear, however, that ordinary air dissolved in water can cause active and serious corrosion, especially if the water is heated.

It may be that the heating which disengages the gas from solution in the water leaves it in something like a nascent state, in which it attacks iron with especial activity. This appears to be the explanation why hot-water pipes in household plumbing corrode so much more rapidly than cold-water pipes. It is quite remarkable that the rate of corrosion appears to be proportional to the temperature of the water circulated and also to the amount of water passing through the pipes. Thus in a system for heating hot water for the supply of a hotel or apartment house, the corrosion is found to be several times as rapid as it is in the hot-water-supply pipes of an ordinary dwelling.

The practical lesson to be drawn from these facts is that provision should be made wherever possible for removing the dissolved air and other gases from water before it is circulated through pipes, boilers, etc., where these gases may do harm. By heating water to the boiling temperature in an open type of heater, the dissolved air and gases will be pretty thoroughly removed; and the life of the pipes through which the water has to pass should be materially increased by this simple precaution in design.

⁂

Lap Joints and Boiler Explosions

While it has been known for a long time, it has undoubtedly not been fully appreciated, that an unsymmetrical boiler-plate joint (well typified by the common riveted type) leads to abnormal plate stresses in the vicinity of the joint, due to the bending caused by the eccentric load. We have noted elsewhere in this issue some experiments which have shown in isolated lap joints, the tension stresses rising to four times the direct-load value. In practical cases of boiler plates in service, the stresses do not seem to rise above twice the direct-load value, due to the stiffness introduced by details of construction such as staggered joints of other longitudinal rings or plates. The danger of abnormal plate stresses at lap joints has been pointed out before and warnings have been made at various times, but it seems evident that, so far as the practical work of many designers and the instruction in technical schools goes, little heed has been paid to these warnings, so that they need to be repeated again and again until they are observed. On that ground, lack of great novelty in the paper abstracted elsewhere is excused by evident utility.

Another phenomenon which has been known and studied for some time, but considered to have little immediate and practical value, is that iron stressed beyond its elastic limit will corrode more rapidly than iron unstressed or stressed only within the elastic limit. Considering this action, together with the peculiar stresses in the neighborhood of lap joints, we have an explanation for the often observed phenomenon of concentration of pitting along joints and bends in boiler plates and fittings. Concentration of pitting effects then in a boiler, along any marked lines or after some definite fashion, may be taken to indicate there the presence of excessive stresses, leading perhaps to rupture. Thus the danger to be avoided multiplies, for deterioration is most rapid in those parts subjected to abnormal and unsuspected loads.

In the case of the New South Wales studies which we have noted elsewhere in this issue, incipient failures were found under conditions which could not be detected by the ordinary boiler examination, but were disclosed by the more searching investigation of those who knew that conditions were proper for such development. This seems to point out an inadequacy in the method of inspection in vogue. The recommendation made by the investigators mentioned that boiler inspectors should use a simple form of stereoscopic microscope is useful and worthy of serious consideration in this country.

⁂

A Safety Type of Locomotive Boiler

In the Literature Supplement of this issue there is reviewed the elaborate report, just published, which has been made by Dr. W. F. M. Goss on the notable tests of the Jacobs-Shupert locomotive boiler, carried out last spring at Coatesville, Penn. It seems to us that this report, and the matter to which it relates, has a public importance which puts it quite outside of the ordinary category of engineering reports upon patented inventions.

The Jacobs-Shupert type of boiler, which has already been fully described in the pages of ENGINEERING NEWS and which is now in extensive use on the Santa Fé R.R., where it was originally developed, eliminates stay-bolted surfaces from the sides and crown-sheet of the locomotive

boiler. Elaborate tests carried out by Prof. Goss, with the practical experience gained in service, have fully demonstrated the large advantage of this type of boiler, so far as safety is concerned, over the ordinary type of locomotive boiler, in which the firebox is surrounded and roofed over by stay-bolted surfaces.

As our readers know, the danger of locomotive-boiler explosions has been considered such that Congress has recently established a national system of inspection for locomotive boilers under the direction of the Interstate Commerce Commission. Probably three-fourths, if not nine-tenths, of the dangers in connection with locomotive boilers are due to the stay-bolted surfaces around the firebox. Under present labor conditions, there is difficulty in maintaining reliable and continuous inspection of locomotive stay-bolts, and such inspection, even when established, is a constant and considerable expense.

Under these conditions the development of a design of locomotive boiler which has equal efficiency and capacity with the present boilers and greatly reduces the dangers inseparable from stay-bolted surfaces, is an achievement of great importance to American railways and, for that matter, to the railways of the world.

A very good way to form an impartial judgment of the relative merits of a new device in comparison with an old one (the new device being assumed to have been thoroughly tested and its practicability and efficiency demonstrated) is to imagine that the new device or new form of construction had been developed first and become adopted as standard practice, and that the old device is then brought forward as an improvement.

The distinguishing feature of the Jacobs-Shupert boiler is the use of rolled plates to stay the inner and outer surfaces of the firebox instead of round bolts with screw threads cut for their whole length. If flanging and riveting machinery had been available in the early days of the locomotive, so that the plate-stay type of boiler had been first developed and come into universal use, one can imagine the difficulties which would have beset any inventor who came forward with a proposition to substitute in place of these plate stays, screwed stay-bolts. He would have been told that his device involved inherent elements of danger which made its adoption out of the question, and that the amount of labor involved in making and placing the screw stays and inspecting them during the boiler's life made his invention impossible from the commercial standpoint as well.

Concerning Government by Investigation

It would require a very industrious man, working overtime, to keep track of the investigations which are going on at the present time. He would be busy if he followed only those reported in the daily newspapers. It has come to be the fashion for every state legislature to appoint one or more investigating commissions. Congress has the same habit in a chronic and confirmed stage. Even the New York Board of Aldermen has awakened from its former condition of innocuous desuetude and has brought itself into the limelight.

We have no protest to make against such investigating commissions; in fact, they are probably the best means of remedying evils in governmental matters where other means of cure have failed; but it is instructive to reflect, after all, as to how little the average investigating commission can accomplish. It can, indeed, if made up of men of the proper ability, arouse public opinion and put things on a better basis for the future; but it can do very little concerning the errors and worse than errors of the past, except in some flagrant cases to bring about the punishment of those who have been guilty of serious breaches of trust.

The old adage is as true in governmental matters as in any others, that prevention is far better than cure. It is far more important that the governmental business shall be so organized that it will be honestly and efficiently conducted than it is to allow a government enterprise or department to be organized on improper lines and then after its blunders and worse have become a public scandal, to appoint an investigating commission.

It seems worth while to emphasize this matter in connection with the principle which has been repeatedly urged in these columns that government work of importance whether carried on by a state, a city or the nation, should be put in charge of a commission of high-class men without regard to political affiliation. It is only by organizing our public works on such a plan that we can make sure of their being carried on by a permanent and competent staff of able engineers.

We have alluded so recently to the unfortunate experience on the New York State highway work, which is now under investigation, that it is needless to comment further on the situation there. It is worth putting on record though that in New York's sister state, Pennsylvania, which is also spending large amounts of state money on highway construction and has now pending a $50,000,000 bond issue for further work, the state highway department is also under fire, and the legislature is demanding an investigation.

In saying this we especially disclaim any intention to reflect upon the Pennsylvania highway department, for we have no information as to whether the state highway work in Pennsylvania has been in any way deserving of criticism. What we do wish to emphasize is that the very fact that the work is in charge of one man makes attack upon the work by members of the opposing political party almost inevitable. We are inclined to believe that this result would follow almost without exception, no matter who the man was who was placed in charge of the work.

Whatever the merits of the Pennsylvania controversy, there can be no doubt that an attack upon the state highway work already done is a most unfortunate way to start a campaign for a $50,000,000 bond issue for good roads in Pennsylvania. We believe those interests which are so industriously agitating for public expenditures upon road construction can do no greater public service than to couple with their demand for state appropriations for good roads the further demand that all such appropriations shall be spent under direction of a non-partisan commission of not less than three men which will carry on the work in an efficient manner without regard to political considerations.

If Massachusetts and other states can carry on public work with continuous economy and success under direction of an appointive commission of high-class men and without the need of sensational investigations every two or three years, it ought to be possible for New York and Pennsylvania to adopt an equally wise policy.

Why Not?

At the recent annual meeting of the American Society of Civil Engineers, held in the Society's house in New York City, two matters which impressed themselves forcibly on all those present at the meeting were in the first place that the auditorium in the Society's house is inadequate to accommodate the members present and enable them to hear what is going on. Probably not more than half the members present were able to hear the various speakers.

In the second place, it is well understood that what attracts three-quarters of those who come from a distance to attend the annual meeting is not the formal proceedings of the business meeting, but the opportunity to renew and extend mutual acquaintance with their fellow members. This opportunity is, to a large extent, lost because the Society's house is not large enough nor provided with the necessary conveniences to enable luncheon to be served to the membership at the close of the business session. The result is that as soon as the session is over, the members split up into small detachments and scatter to various hotels, restaurants and clubs.

It was the general appreciation of these conditions that led to the adoption of a motion at the recent annual meeting instructing the Board of Direction to consider the enlargement of the Society's house so that it would be of sufficient size to accommodate at luncheon the members present at the annual business meeting.

Is this a wise and efficient use of the funds accumulated from the dues paid by the Society's members? Does it not, on the other hand, seem almost the climax of inefficiency in the use of capital to expend $50,000 or $100,000 additional on the Society's building in order that *once a year* the house may serve to accommodate those present at the annual meeting? Is it an example of good engineering management in the economic use of capital to erect this costly building on this valuable real estate when it will lie idle 364 days out of 365?

There is, fortunately, a way by which the members who attend the annual meeting of the American Society of Civil Engineers can be accommodated in what is, we believe, without exception the best auditorium in New York City and can afterward meet each other at luncheon in the same building with ample provision for service. They can have these accommodations, moreover, at no other cost than a moderate rental.

We refer to the auditorium in the Engineering Societies' Building, which is now rented for large gatherings not only by the three national societies which joined in the erection of the building, but by numerous other engineering societies having headquarters in the building and elsewhere. As many of our readers know, there are in the same building spacious rooms for serving luncheon, which are frequently used by these other societies on the occasion of their annual meetings.

If there is any sound and sufficient reason why the American Society of Civil Engineers should not lease this auditorium and luncheon room for use at the time of its annual business meeting in New York, it has yet to be brought to our attention. The idea that the annual business meeting must be held in the Society's own house, purely as a matter of sentiment, can surely be dismissed at the present time. So may also the idea, which was more or less strenuously urged a dozen years ago, that the Society would lose something of its independence by sharing with other societies the use of an auditorium. Experience has demonstrated that the national engineering societies whose headquarters are located in the Engineering Society's Building are exactly as independent of each other in their organization and conduct as they were before they coöperated in its erection.

Great progress has been made in the past dozen years toward the establishment of coöperation between all the different national societies. Many prominent engineers hold membership in two or more of these national societies, and the list of those who have served on the governing boards of the different societies, if one looks back a half dozen years, reads like the "interlocking directorates" that are now attracting so much attention in the financial world.

Under these circumstances we believe the great majority of members of the American Society of Civil Engineers would approve the rental of the auditorium in the Engineering Societies' Building for the Society's annual meeting rather than have the Society incur a new burden of debt for enlarging its house.

⁂

Improving the Railway Freight Service

The efficiency of railway freight-car equipment is determined by the proportion of time which it spends in actually moving freight over the line, and the very low efficiency of such equipment on American railways is a recognized condition which appears to be too generally accepted as necessary and inevitable. Progressive operating officials realize that this is not the case, but the individual can do little to improve the conditions; what is needed is concerted action and coöperation, with active encouragement by the management or higher officials. The present low service-efficiency of the equipment is due to the fact that each car averages but a very short run and a very short time on the road daily, and a small ton-mileage per day. At a recent meeting of the operating officers of the Illinois Central R.R. this subject was dealt with forcibly in a paper by J. M. Daly, the Superintendent of Transportation, who discussed the actual conditions, their causes and the means of remedying the conditions.

From the brief abstract of the paper, which is presented elsewhere in this issue, it will be seen that the remedy suggested by Mr. Daly consists in closer checking of the movements of individual cars and closer supervision of the work at yards and terminals in order to reduce the present excessive proportion of time spent by cars standing idle instead of moving over the road. It was pointed out in the paper that the day is past when a yard-master could effectively manage his yard or terminal by personal work in the yard. At the present time he is (or rather he should be) an officer in control of the situation, and competent to realize that his work is not simply that of operating a yard, but rather that of operating a part of a railway system. Too many of these men aim simply at low cost of yard operation, with the result (as noted by Mr. Daly) that where they save in the pay-roll by discharging one or two yard clerks, they may cause the railroad a loss of a hundred times the amount in per-diem charges and also a loss in business, due to the absence of the checking done formerly by the yard clerks. These clerks are apt to be looked upon as a sort of necessary

evil, and little help or encouragement is afforded them by their immediate superiors, when in fact their work is of great importance to the efficient operation not only of the yard but of the railway as a whole. The paper goes into detail as to the proper checking by a large force of experienced and active yard clerks, but these details we need not consider. To press home the point, Mr. Daly states that a terminal having 6000 cars represents an investment of $6,000,000 in cars, about the same for tracks and facilities, and about the same for the lading in the cars, or say a total of $15,000,000 to $20,000,000. He asks: "Does not this justify the employment of the best men available, both at the head and in the ranks."

Under present conditions the actual movement of cars over the road averages but a few miles and a few hours per day. The great proportion of the time is spent standing idle on yard tracks while consignees are clamoring for their freight and shippers are clamoring for empty cars. Undoubtedly this is a very defective feature in railway operation and management, and it is one to which some efficiency system might well be applied in order to improve the service to the public and to enable the railways to get better service from their equipment. When freight cars average an effective travel of only 27 miles per day, and an actual running time of only three hours per day, as on the Illinois Central R. R., it is small wonder that there is endless complaint of the public at inefficiency on the part of the railways. The purchase of additional equipment is no adequate remedy, but serves to increase the confusion and delay and produces no real improvement in the freight-handling service, so that the investment is largely wasted.

It is unfortunate that the railways seem unable to realize the effect of these conditions, both upon the operating economy of the railways themselves and upon the relations between the railways and the public. Their higher officers, and particularly the men in power whose authorization and backing are needed, give apparently little heed to the demands or necessity for radical changes which will effect large improvements, but are largely content to devote their attention to matters of minor detail rather than to those of fundamental importance. Under such conditions there is little encouragement for the active operating officer who is anxious to improve the conditions, and little spur to rouse to activity the easy-going officer who is well content to let things remain as they are and have been. The indifference to this important matter cannot be due to lack of knowledge of the conditions, since these conditions have been set forth plainly and frequently by men in railway service as well as by outsiders, and they have been set forth in regard to individual railways as well as to the railway system as a whole. For example, it may be questioned whether Mr. Daly's clear and definite presentation of the matter has had any wider effect, even on his own road, than a possible "punching-up" of yardmasters and minor officials, with only temporary effect.

In what has been said above we are not unmindful of the fact that there are active and progressive officials, many of them. But the fact remains that probably on no railway in the country is the freight movement nearly as rapid or efficient as it should be. This is not saying that new cars are not or may not be necessary. It is simply saying that the present cars are not worked to anything like their real efficiency. The problem of improving the freight service includes such factors as yard design and operation (both for division yards and terminals), industrial service to factories, etc., car interchange, the maintenance of cars in proper condition and the regulations relating to time limits, demurrage, etc., on cars while in the hands of shippers, consignees and foreign roads. But one of the most important is the service or performance of the cars, and it is this which requires much more attention than it now receives.

LETTERS TO THE EDITOR

The True Story of the Lake with a Long Name

Sir—The letters you published on Dec. 5 and Jan. 2, regarding the name of a lake near Webster, Mass., recall some notes I made in connection with the resurveying of the Connecticut-Massachusetts state boundary. All of the following versions of the lake name have appeared in print, some in the Hartford *Daily Times*, between Apr. 16 and 20, 1907, but the collection as such is original. If any engineer outside of the German empire has ever run out a longer name, I would like to hear from him.

The name is never printed with the syllables separated, but it is impossible to make sense of the word unless this is done and it really is proper to attach a certain meaning to the combination, as it is a violent corruption of certain Indian names. J. Hammond Trumbull, in his "Indian Names in Connecticut," gives the spelling used by Elliott, "the Apostle to the Indians" (1668), as Chaubun-a-kong-ko-muck, meaning a boundary place and applied to a town near the pond. The pond itself was called Chaub na-kung-a-maug, i.e., "boundary fishing-place" or "fishing place at the boundary," the last syllable being a regular Algonkin termination meaning "fishing place." Chabenuck was a Massachusetts Indian word for "that which divides," a "bound mark," and this country lay between the Mohegan and Narragansett Indians. Manchaug was a village of Christian Indians in the Nipmuck country east of the lake and the name is still applied to a small pond in the vicinity.

The trouble started when a clerk in our office received a picture postal card bearing the legend "Greetings from Char-gogg-a-gogg-man-chaugg-maug" (9 g's out of 26 letters). A reporter happened to be passing by in the street when the man tried to pronounce it, and he rushed in to see what was the matter and scooped the poor fellow's obituary. Next day a constant reader assured the *Times* that the only reason the word stopped at "chaugg maug" was that the postal-card printer had no more g's

in his font. He quoted a name, which but for the linotype, would have stumped even the newspaper: Char-gogg-a-gogg-man-chaugg-a-gung-o-maug (11 g's in 36 letters).

Another old resident went him one better next day with Char-gogg-a-gogg-man-chaugg-a-gogg-chaub-un-a-gung-amaug (14 g's in 42 letters). The last 17 letters of this version (what a Webster man might call the last syllable) is the name which appears on the state topographical maps. The inter-state boundary map of 1822 uses exactly this spelling and Chandler and Thaxter used it in the survey of 1713 with only a slight difference, "Chab-un-a-gung-a-muog." It is sometimes corrupted into Chawyermothersgingerbread, but it is probably the generally accepted Indian name for the lake.

Now, however, comes another *pro bono publico* who not only sticks in two more g's, but attempts to gild the 37-letter pill by saying that it means "Pleasant Water." "Char-gogg-a-gogg-man-chaugg-a-gogg-a-gung-a-maug" might be pleasant as a gargle, but it is rather heavy for a beverage.

The only thoroughly consistent and really probable account of the whole matter is suggested by a letter writer who formerly lived at Webster, but who moved away so long ago that his brain has had time to clear itself of the storms of consonants which seeth through the minds of his fellow correspondents. By applying the integral calculus we find his version (or vision) of the name to have 55 letters, 20 of them g's. It means "Dead Man's Lake," he says, and, "some years ago the skeleton of a dead Indian was dug up on the banks. It was in a perfect state of preservation and is now in a museum in New York State"—town not given. "The Indian was 8 ft. 4 in. tall!"

The facts, undoubtedly, are that this was the ancient king of the pond; the identical Indian who first showed the lake to the white men. Stooping down to drink some of the pleasant water he choked. The water lost its way in his 8-ft. windpipe and he died. The white men, mistaking his dying gurgles for his untutored attempt to tell the name of the lake, wrote it down thus, "Char-gogg-a-gogg-au-gogg-o-gogg-man-chaugg-o-gogg-charb-un-a-gung-a-maug."

HENRY R. BUCK.

Hartford, Conn., Jan. 30, 1913.

The Status of the Engineer

Sir—Anent the discussion of the above subject now going on in ENGINEERING NEWS, it is to be regretted that persons taking part in the same consider it proper to take refuge under such *nom de plumes* as "Prominent Engineer." In order that their views may be of force, they should at least have moral courage enough to back them up with their real names.

The country is brim full of "Prominent Engineers," a sobriquet which is often assumed by engineers not so prominent, and if a person has the nerve (!!!) to send young fellows away with their ears burning, the reader should at least know who this redoubtable person is. The trouble with the great majority of engineers is they are too modest, at least for their own good.

EMILE LOW.

606 Ashland Ave., Buffalo, N. Y.
Jan. 30, 1913.

Increased Flow of Springs Just Before Rains

Sir—Allow me to suggest another explanation than that given by S. P. Baird, for the increased flow of springs preceding rains. Mr. Baird (see p. 83 of your issue of Jan. 9, 1913) has observed that the flow of some springs increases as much as 100% from 1 to 48 hours before a rain. He explains it on the theory of decrease in air pressure. Undoubtedly a decrease in air pressure will increase volumes of water on and near the surface, but the magnitude of this increase would be inappreciable. The increased flow depends upon the head, and this in turn upon the supply from the source of the spring. Perhaps an explanation is afforded in an analysis of the source.

The disposition of precipitation on the earth's surface is accomplished in three distinct ways: (1) surface run-off; (2) evaporation, including transpiration; (3) underground flow. For a certain area of average conditions the surface run-off is quite limited as to time, while evaporation and underground flow go on continuously. If evaporation is small, underground flow is large; what affects evaporation, therefore, affects underground flow in an inverse manner. But evaporation depends on a good many meteorological conditions, and is especially dependent on the relative humidity of the air. Other conditions being the same, evaporation decreases as relative humidity increases. As the latter increases toward 100% the former decreases toward zero, and underground flow approaches its maximum. But these are meteorological conditions conducive to rain in a day or two. Let us, therefore, rather try to explain the sequence of rain after decrease in air pressure by calling attention to the fact that the air is always engaging in an effort at maintaining equilibrium. If there has been an appreciable decrease in pressure over a certain area it usually means that heavier and colder air will sooner or later be rushing toward this area; relative humidity will rise to supersaturation and eventually we have condensation and consequent precipitation.

JOHN BERG.

220 South Michigan Ave., Chicago, Ill., Jan. 18, 1913.

Cost of Steel vs. Wood for River Barges

Sir—In your issue of Sept. 26, 1912, there appeared a criticism by John L. Taylor of my article in your issue of Aug. 29, 1912, on "Steel vs. Creosoted Wood for River Barges."

Mr. Taylor evidently thinks I was comparing the cost of wooden barges built in the early '90's with the cost of present day steel construction. He cites a case where the following bids were received in 1911 on two gravel barges 100x22x5 ft.

$2950 lowest bid on untreated wood.
4300 lowest bid on steel.

In my original article the following figures were used for barges 100x20 ft. by 4 ft. 7 in.

$1200 untreated wood.
4000 steel.

It will be noted that the cost for steel cited by Mr. Taylor supports the cost I used for the steel construction and also tends to indicate that my figure of $4000 was

conservative, in that it was a low price for a steel barge 100x20 ft. by 4 ft. 7 in. On the other hand the lowest bid received for untreated wood was $2950. This figure seems exceedingly high, for in 1910 the U. S. Boatyard at Stillwater, Minn., constructed untreated-wood barges 100x20 ft. by 4 ft. 7 in. for $1000 each; in 1909 the U. S. Boatyard at Fountain City, Wis., built similar barges of untreated wood for $1068 each. From the above it will be noted that the writers' figure of $1200 was conservative, for it is a high figure for an untreated-wood barge 100x20 ft. by 4 ft. 7 in. From the above it can be seen that a steel barge 100x20 ft. by 4 ft. 7 in. would cost three times as much as an untreated barge of the same size. In my original article attention was called to the fact that all costs of timber barges were based on government freight rates, and that for commercial comparison $10 per barge should be added to the yearly cost. However, when this item is added to the above actual costs the ratio still remains 1 to 3.

The following direct comparison of the lowest bids received on steel construction with the actual cost of similar barges built of creosoted wood is of interest. On Oct. 6, 1909, the U. S. Engineer Office at Vicksburg, Miss., received bids on steel barges 120x30x6 ft. These barges were afterwards built at the U. S. Dry Dock at Keokuk, Iowa, of open-tank creosoted Douglas fir. The bids received on steel and the actual cost of the creosoted wood construction are given below:

Bidder No.	Material	Price each	Total cost of 4 barges	
1	Steel	$11,873	$47,492	
2	Steel	12,500	50,000	
3	Steel	13,300	53,200	
4	Steel	15,939	63,756	
5	Steel	16,000	64,000	
6	Steel	10,750	43,000	lowest steel bid.
Open-tank creosoted Douglas fir		3,650	14,600	actual govern. cost.

It will be noted that the ratio of the actual government cost for open-tank creosoted wood to the lowest steel bid received is 1 to 2.95.

In 1911 the U. S. Engineer Office at Rock Island, Ill., received bids on 40 steel pontoons 38x14x3 ft. All bids were rejected and the pontoons built at the U. S. Dry Dock at Keokuk, Iowa, of open-tank creosoted yellow pine with flaring sides and concrete decks 38x14 ft. by 4 ft. 4 in. The bids for steel pontoons and the actual government cost were as follows:

Bidder No.	Point of delivery	Price of each without 18-in. pipe	Total cost of 40 pontoons	
2	Lockport, Ill.	$854	$34,170	lowest steel bid.
3	Grafton, Ill.	1128	45,120	
4	St. Louis, Mo.	1058	42,295	
1	St. Louis, Mo.	1421	56,820	
5	St. Louis, Mo.	1096	43,820	
Creosoted wood and concrete deck, Keokuk, Iowa		313	12,520	actual cost.

It will be noted that the ratio of the actual government cost for open-tank creosoted wood with concrete deck to the lowest bid received on steel construction is 1 to 2.73.

In 1910 the U. S. Engineer Office at Rock Island, Ill., received prices on 10 steel barges 110x24x5 ft. The lowest bid received on barges built of steel and the actual cost of barges built of pressure creosoted Douglas fir at the U. S. Boatyard, Fountain City, Wis., in 1912 are as follows:

Bidder No.	Material	Price each	Total cost of 10 barges	
1	Steel	$5,100	$51,000	lowest steel bid.
2	Steel	6,300	63,000	
3	Steel	6,400	64,000	
Pressure creosoted Douglas fir		2,000	20,000	actual cost 1912

It will be noted that the ratio of the actual government cost for pressure creosoted wood to the lowest price received for steel construction is 1 to 2.25.

A. E. HAGEBOECK,
In Charge Creosoting Operations,
U. S. Engineer Office.

Rock Island, Ill., Dec. 1, 1912.

The Value of Foresight in Engineering

Sir—A long time ago—doesn't it seem so?—in ENGINEERING NEWS of Feb. 3, 1898, there was published an editorial with the alluring title "The Value of Foresight in Engineering." Its purport was that it was the duty of the engineer to look ahead in designing. One might even think from the article that it was fairly easy to do so. Is it so easy? For example, let us look backward and forward on a big job that our engineers began about a decade ago and that is now nearly done. I refer to the Panama Canal and the estimates of its traffic.

When the Isthmian Canal Commission of 1901 made its report, the probable traffic of the canal by 1914, a year that has now nearly rolled around, was estimated at 6,401,332 tons; a few months ago Prof. Emory R. Johnson (who made the first estimate) in his report on the proposed tolls for the canal put the estimate of traffic in 1914 at 10,500,000 tons. This shows clearly that forecasting the future is not at all easy, but very difficult. Still more difficult—if we take discrepancy as a measure of difficulty—does it appear if we take the estimates not of one man only but of several men. In the *Railroad Gazette* of Nov. 15, 1901, S. D. Webster, of St. Louis, gave some estimates of "outsiders" of the traffic of the canal ranging from the 300,000 tons by "those who have given the matter careful consideration" to the 8,000,000 tons of "most ardent promoters" and said that "Mr. Nimmo says, 500,000 tons." Mr. Webster himself used 4,000,000 tons as a "friendly" estimate. What a difference between 300,000 and 10,500,000!

Does not all this diversity of estimates of traffic, on the preparation of which lots of money was spent, go to show that forecasting the future is difficult?

A. P. C.

Nashville, Tenn., Jan. 27, 1913.

[Of course, forecasting the future is difficult (that is to say, it requires men of large ability and experience), but so is any important and intricate problem which the engineer has to solve difficult. If engineering work was so easy that any man who pursued a prescribed course of study could perform it perfectly, engineering would very soon become a skilled trade, not a profession.

What is of particular interest in our correspondent's letter, however, is that it illustrates most admirably the value and the importance of forecasting the future in engineering design, and, further, it shows how accurately it is possible by scientific methods to make such forecasts.

The quotations from the *Railroad Gazette* above should, of course, be left out of the account. Those were not estimates at all, but mere guesses, and are no more to be compared with Prof. Johnson's figures than one should compare the guess of a passer-by as to the cubic yards in a railway embankment to be built across a valley with the estimates of the engineers who make the survey for the line. Besides, some of the so called "esti-

mates" of future Panama Canal traffic circulated a dozen years ago were probably made to injure the canal enterprise.

The real comparison to be made, therefore, is of the first estimate of the canal traffic in 1914 made in 1899, which set its volume at 6,400,000 tons and the second estimate made in 1912, based on statistics of the world's ocean traffic in 1910, which set the traffic of 1914 at 10,500,000 tons.

Assuming that the latter figure will be actually realized, it indicates that the estimate of 1899 erred somewhat on the side of conservatism, which is the sort of error an engineer prefers to make. To assume a parallel case: If an engineer for a projected railway line estimated its probable volume of traffic at a period 15 years in the future and the actual traffic proved to be about 50 per cent. in excess of his prediction, he would have done marvelously well.

It is, of course, recognized that any forecast of the future in the form of an estimate must be subjected to a large percentage of possible error. But so must a great many of the calculations which an engineer makes, even such supposedly accurate calculation as the stresses in a bridge truss.

The fact that a large percentage of error must be allowed for, however, is no argument against making the calculation or against its usefulness to the designer.—ED.]

The Control of Banking over Industry

Sir—In your issue of Jan. 23 there are two articles which, while not intended to be so, might, I believe, very properly be considered together. One is the discussion by Messrs. Stillwell and Whinery on the "Status of the Engineering Profession." The other is your editorial on "The Control of Banking over Industry." Since Industry, either directly or indirectly, furnishes employment for the engineers, then, if Banking controls Industry, it necessarily follows that the bankers who control the banking must indirectly fix the status of the engineers.

Messrs. Stillwell and Whinery speak for a large number of engineers who regret that the engineering profession, as a whole, is not held in higher esteem, and wonder why. The answers, for there are doubtless many of them, are not simple, but it seems to me that your editorial gives a clue to at least one of them.

You say that it is "time for thinking men to inquire as to the conditions under which we are living and working." By all means, but, since the problems are so serious and important, let us be quite sure that we are thinking clearly and sanely. Let us really think; not merely think that we think. If we do think clearly and sanely, when we pursue our inquiries we shall find out a number of things which are not now visible to that public which "receives with no satisfaction these revelations of vast power and huge profits" which the bankers have acquired.

We shall see, I believe, first of all, the manifest injustice of placing these eminent gentlemen in the dual capacity of defendant and witness for the prosecution before an investigating committee which is itself both prosecutor and judge, in order to establish the preconceived proposition that certain alleged facts are evil in themselves or the result of evil conditions.

Referring specifically to your editorial; suppose the banking firm did "almost automatically" come into control of the property; was not the property both honestly and ably managed? If the common stock was issued largely on hope, was the public deceived or victimized when it fixed the selling price around $8 a share? And when, through the able management of the company, the price of the stock rose to above $90 a share, or, if that is considered too speculative, its present price of about $65, is the public, who is paying the bills for investigations without number, in need of either pity or protection?

If we "contemplate the long list of bankruptcies and receiverships" with an open mind and not with a "prejudice excited by flaming headlines" after due investigation, we shall see, I believe, that most of them occurred in companies that were less ably and, in many cases, less scrupulously managed, and among the companies that did not enter any combination and remained single and weak instead of recognizing the axiom that "in union there is strength."

You ask, "Whence come these enormous sums of money?" Do they not come primarily from the investors and depositors who place their money where they believe it will be both honestly and intelligently used? The gentlemen who testified before the Pujo Investigating Committee were entirely ready to admit that if this vast power got into the hands of bad or incompetent men the results might be disastrous; but the Committee utterly failed to show how such men could obtain control or how they could keep it if they did get it.

Credit is the most sensitive thing in the business world and it is a short memory that does not recall how quickly during 1906 and 1907 a run on a bank started on the slightest suspicion of either moral or financial weakness. The Carnegie Trust Co. and Mr. Morse's shipping combination, to mention only two instances, were institutions of no small financial strength which went to pieces when those in control were tried in the balance and found wanting.

You say that "probably the distinguished financiers who testified before the Pujo Committee would claim that the men who wield this enormous power are such good men that nothing of this unrighteous sort ever actually happens," and suggest the possibility that others holding high executive positions might tell a different story; but I believe it is also indisputable that, if there were a different story to be told, the Committee had as its counsel a man who was as able and willing to find it out as any counsel that any committee ever had.

These gentlemen who are alleged to form the "Money Trust" do wield enormous power and have made profits beyond the dreams of avarice; but that the power and profits are the result of anything but a fortuitous combination of great ability, unquestionable integrity and favorable opportunity is not yet an established fact. I believe it to be easily demonstrable that the profits bear a no greater proportion to the capital invested that have been repeatedly made during the same length of time in gold or oil or copper or even in New York real estate; and I have recently been told on the best of authority of a gentleman who enjoys an income of $80,000 a year derived from an original investment of $10,000 in a manufactured article in common use which, on a percentage

basis, makes the profits of even the most successful banks look small by comparison.

Now what has all this to do with the status of the engineering profession? Simply this, that the engineering profession will never be recognized as Messrs. Whinery, Stillwell and others wish it to be recognized, will never get the position that they want it to have until its members show their ability to think clearly and sanely and broadly on other matters than engineering alone.

At a dinner in New York a few nights ago, Col. Goethals was hailed, and I believe rightly so, as the greatest engineer of the present day. Will anybody say that it was his engineering skill alone that won him his fame? Was it not also his ability to think clearly and broadly and quickly on all the administrative and executive problems that were presented? We can not all be Col. Goethals, but we can all do our best to think clearly and broadly and sanely on the very pressing problems of the day and to help others to do so. When the engineering profession takes this kind of leadership, its status will be recognized without the aid of legal enactment.

ALEX. L. BRODHEAD.

Catasauqua, Penn., Jan. 31, 1913.

[Our correspondent asks the question, "Suppose the banking firm did 'almost automatically' come into control of the property, was not the property honestly and ably managed?"

In reply it may be said that the very essence of the criticism is that in too many cases the properties have not been honestly managed, but have been run for the benefit of the inside interests in control, with little regard to the interest of the real owners, the holders of the bonds and stocks.

We need not take space to enumerate specific instances. The financial history of the past dozen years is full of them. As for "the companies which did not enter into any combination and remained single and weak," there are also conspicuous instances of concerns which stood outside the combination and have proved their ability to compete with it and prosper to a greater degree than the combination.

Concerning the source of the enormous deposits in the banks, one important fact developed by the insurance investigation a few years ago was the huge amount of cash carried by the insurance companies in the shape of bank deposits which might have been invested for the benefit of policy holders.

We said in the editorial referred to that the banker as the trustee of the business communities' reservoir of capital and credit performs a most valuable public service, and one deserving ample compensation. It is when he uses this trust for his own undue profit or when he uses his great powers to break one concern and build up another which ought to have equal opportunities for success that he becomes an element of as great danger to the public welfare as those who attack property rights or preach the doctrine of anarchy.—ED.]

NOTES AND QUERIES

Erratum—In the article on "Expanded Metal Lath," in our issue of Jan. 23, it was stated (p. 168) that for ceiling work there was no trouble with supports spaced 12 in. apart. This should have read "24 in. apart."

In our issue of Dec. 26, in the course of an article on "Use, Waste and Metering of Water in Chicago," the water consumption of Providence was given as 40 gal. per capita, on the authority of the report, which formed the basis of the article just named. Chas. G. Richardson, of Providence, R. I., writes us that the latest records of the Providence water department show the per capita consumption to be 65 gal. daily.

F. C. W., Sheridan, Wyo., writes: "Noncorrosive, corrugated iron pipe is being used a great deal for flumes and siphons in the West. It has been suggested to extend its use to storm sewers instead of using vitrified sewer pipe. If engineers have used this iron pipe for storm sewers, it would be most interesting to learn with what success."

Elimination of Timbering in Rock Tunneling: A Proposal

BY JOHN F. O'ROURKE*

Rock tunneling for railways or other purposes is difficult and expensive when the rock does not possess sufficient solidity to prevent falling of the roof when unsupported. In such cases the roof must be timbered, i.e., held up by timber supports, varying in amount from simple conditions, when a few posts here and there will do, to conditions of "heavy" rock, when it is necessary to use close segmental arching of heavy timber from side to side. The cost of the timber, the expense of preparing the bearings for it in the rock, and the time lost in placing it are items in the additional expense of tunneling under these conditions. Anything that can be done to reduce or avoid the necessity for timbering is of the greatest importance in the art of tunneling.

The accompanying drawings show a new method of placing lining in a loose rock tunnel, which avoids the necessity for timbering and at the same time produces a tunnel structure equal, if not superior, to anything heretofore built or proposed. The cost of the lining built by this method is no greater and probably less than that built in the ordinary way. The method depends on the use of the O'Rourke interlocking concrete blocks which were described in ENGINEERING NEWS, Nov. 28, 1912, p. 1022. The shape of these blocks is such that they can be set in place and built into an arch without centering, and form a complete and secure arch as soon as keyed up. Thus they make it possible to keep the lining built in a fully supporting condition close up behind the working face, provided the individual operations are carried on in the order and manner described below.

An important part of the economy in using this block method of lining is the avoidance of the additional excavation necessary for placing the timbering outside the lining; in the case of full timbering this amounts to 15% or more. Moreover, if side posts are not used to carry the timber arch, benches have to be prepared in the rock at the spring line. This operation, which is both slow and costly, is, of course, eliminated in the proposed method.

As illustrated in the drawings herewith, the method employs two side bottom headings driven at the grade of the bottom of the tunnel, and a center top heading driven along the top of the arch. The bottom headings are carried along in advance of the top heading, and the side walls are built up to the spring line. At intervals openings are made between the top and bottom headings

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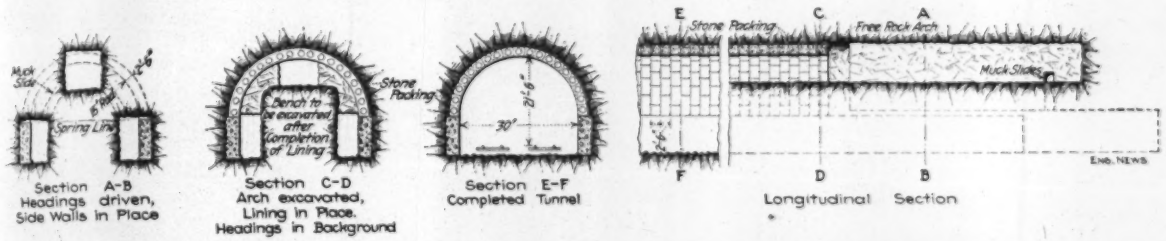
for the disposal of the excavated material of the top heading through the bottom headings. Following the heading work, the rock between center and side headings along the roof is broken down, in lengths as short as the character of the rock demands, and the rings of lining blocks are erected immediately behind this excavation. As soon as each ring is erected, the packing between this ring and the overlying rock is done, so that the ring carries its part of the roof. Thus, except in the headings, the only unsupported roof is over the short length of arch excavation, which can always be kept so short that the roof will be stable without timbering.

In the case of very bad rock, short posts from the bench to the roof can be put in wherever necessary and the rock cleared away for each lining block separately. In this case, as each block is placed it would be supported with posts when necessary until the ring is completed, and the roof packing over it would be done as the erection of the ring goes on. When all the blocks of the ring are in



SKETCHES SHOWING METHOD OF TUNNELING IN HEAVY GROUND WITHOUT TIMBERING, USING INTERLOCKING CONCRETE BLOCKS

place, the ring can take its load and the posts may be removed.

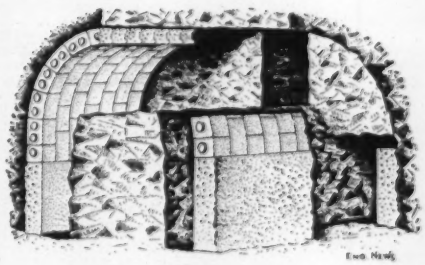
In the method of tunnel construction proposed in this article, the central core of the tunnel excavation is left in place, as the sketches show, until the lining is completed. Thus it affords a firm support during the difficult part of the operation; and the amount of excavation during the real tunneling portion of the work is greatly reduced since the removal of the bench is deferred and can be done later in the completed tunnel under the most favorable conditions.

As the muck from the top-heading excavation is removed through the bottom heading, a way is open for bringing in material and for carrying a traveler to erect the lining, free from interference with the work of excavation or with any of the other operations incidental to the tunneling. The traveler can be made as wide as the arch, and if necessary may be extended down into the side headings to the spring line, so that the entire arch is accessible from the traveler and the hoisting and setting machinery of the traveler can be designed to reach all the parts of the arch. An upward-projecting metal screen carried at the front of the traveler will protect the forward face of the concrete-block lining from any injury by the blasts required in removing the wedge of material between top and side headings.

The principal feature of the O'Rourke concrete block, as already described in ENGINEERING NEWS (Nov. 28, 1912, page 1022), is that each block has two or more projections on one side face with corresponding recesses in the opposite face, so spaced that the blocks in successive rings break joints and thus lock the rings together securely, the projections and recesses furthermore being of such length and depth as to leave an open joint space between faces of the blocks. The outer edges of all the joints are provided with moldings to reduce the size of the joints there and serve to retain a waterproofing preparation for preventing the entrance of water or other material from the outside. The blocks are placed without mortar at the time of setting, and the longitudinal joints are wedged so as to be capable of transmitting arch thrust even before the joints are filled. The subsequent joint filling may be done by any one of many different methods.

As the projections and recesses of these blocks fit together snugly, any one block, when set, is carried by the previous ring, and therefore centering or falsework is unnecessary. This is the feature utilized in the method proposed by the present article.

The manufacture of the blocks in advance at a plant outside of the tunnel gives greater economy than is possible when concrete is mixed and placed in forms inside the tunnel. At the same time a perfect concrete is insured by reason of the ease with which the individual blocks may be inspected and tested. Incidentally, all possible troubles from shrinkage of the concrete in drying are avoided, since the shrinkage of the individual blocks has already taken place before they are set in the tunnel.



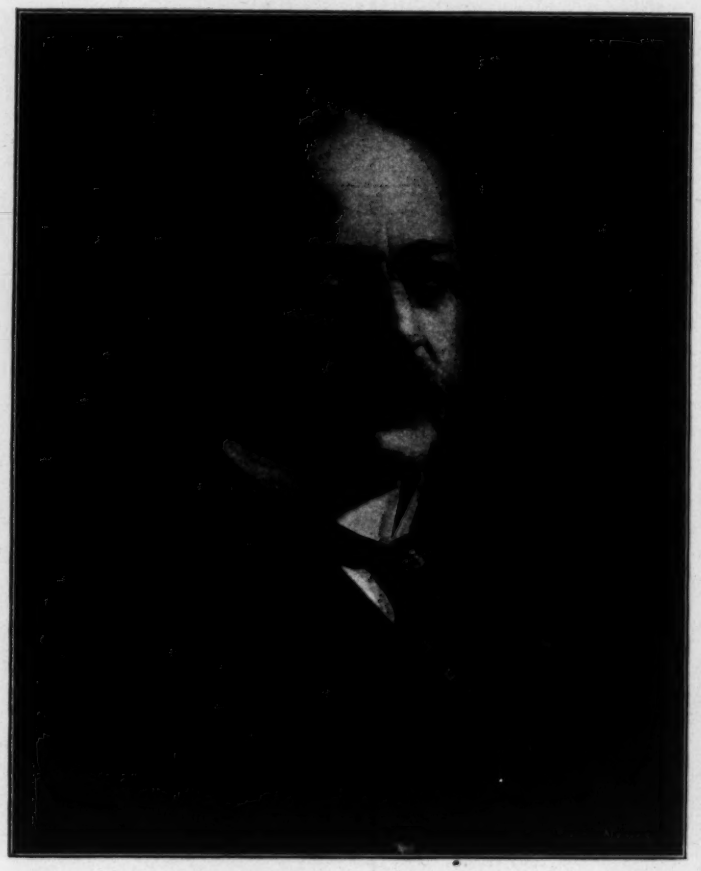
Tunnels in firm clay so large as to require a roof shield like those in Boston Harbor can be driven by the method described in this article without roof shield or timbering. The method would also be capable of use in softer material, or in sand, but here each individual case would have to be considered by itself, and at present only the general statement can be made that a reduction in amount of timbering and an increase of speed would be attainable by using this method.

It might be interesting to state that, in the writer's experience, tunnel timbering has cost his company approximately $100 per M. ft. b.m. in one case. In proposing very recently to build some rock tunnels, the bids for the tunnels timbered and lined in the usual way were higher by $65 per lin.ft. than for the same tunnels built without timbering by the help of the concrete-block lining as described.

D. McN. Stauffer

David McNeely Stauffer, a member of the editorial staff of ENGINEERING NEWS for nearly 25 years, died at his residence in Yonkers, N. Y., on Wednesday, Feb. 5, after an illness of many months' duration.

Mr. Stauffer was born in the village of Richland (now Borough of Mt. Joy), in Lancaster County, Penn., Mar. 24, 1845. His father, Jacob Stauffer, was a solicitor of patents and a naturalist of some fame, numbering among his friends such men as Asa Gray, Agassiz, and Joseph Henry. The Stauffer family was of Swiss origin and has been traced back to Thun, Switzerland. On his mother's side, D. McN. Stauffer was descended from the McNeely and Knox families, representatives of whom came to America from Scotland and Northern Ireland about 1720. Jacob Stauffer removed to Lancaster, Penn., in 1858, and his son David entered the secondary schools of that city. He graduated from the Lancaster High School in 1862, passing through the four classes in three years and in that period maintaining the head of his class. In accordance with an agreement between the city of Lancaster and the old Franklin and Marshall College, there located, the city was permitted to send one student a year to the college free of tuition fees. This scholarship went to the graduate of the High School who had maintained leadership of his class for his four-year term. In accordance with this, David McN. Stauffer was granted this scholarship.



D. McN. Stauffer.

But in those stirring days of the Civil War it was difficult for an active, energetic lad to fix his mind on studies. Although only 17 years old, David Stauffer enlisted, on Sept. 12, 1862, in the Second Pennsylvania Emergency Regiment, and was present at the battle of Antietam, under Gen. Reynolds. At the end of the campaign he was discharged with the regiment and entered the Freshman class of Franklin and Marshall College.

On June 15, 1863, he again enlisted in Independent Battery I, Pennsylvania Light Artillery, under Capt. R. G. Navin. This battery was being organized at Camp Curtin, near Harrisburg, at a time when Lee's invasion of the North, which culminated at the battle of Gettysburg a fortnight later, was arousing all Pennsylvania. The battery did duty near Carlisle and was then sent to Philadelphia for a time to suppress expected riots, and finally to West Virginia. Mr. Stauffer was mustered out of the battery as a corporal, at Harrisburg, Penn., on the expiration of his six months' enlistment, Jan. 9, 1864.

On Feb. 5, 1864, he received, through the recommendation of Admiral David D. Porter, an appointment as master's mate in the U. S. Navy, taking the place of Vincent Porter, son of the admiral, whose death had just occurred. Mr. Stauffer was assigned to the U. S. gunboat "Alexandria," which was commanded by David Porter Rosenmiller, a cousin of the admiral. By virtue of being the only other line officer on board, Mr. Stauffer, although not yet 19 years old, at once became executive officer.

The "Alexandria" was ordered to join the First Division of the Mississippi River fleet, with headquarters off Donaldsonville, La. She was engaged here in fighting guerillas, chiefly along the coast, and entered upon the Red River campaign, but was sent back to her station owing to insufficient protection to her men.

On Apr. 1, 1865, Mr. Stauffer was promoted to the rank of Ensign, U. S. N., and from July 1 to Nov. 1 he was in command of the "Alexandria." In June he witnessed the surrender of Gen. Kirby Smith, the last Confederate commander to surrender. On Nov. 5, 1865, Mr. Stauffer was honorably discharged from the U. S. Navy with the "thanks of the Department for faithful and honorable service."

It was hardly to be expected that the youth of 21, who had carried responsibilities such as are usually borne only by men of mature years, had occupied positions of command and had lived for the better part of three years in the midst of war's excitement, would return to the quiet life of a student and finish his college course.

The active life of the civil engineer had much more attraction for him, and on the same day that he was discharged from the Navy he began work on the surveys for

the Columbia & Port Deposit R.R., in eastern Pennsylvania as a rodman under John A. Sheaff. He remained with the company until May 30, 1868, when he was appointed assistant engineer on surveys and construction for the Philadelphia & Reading R.R. On Aug. 12, 1869, at the age of 24, he was promoted to the position of division engineer, and put in charge of construction of the Allentown R.R.

The boom in railway construction which took place at the end of the Civil War had a collapse in 1870, and the Reading company suspended work on its extensions. Mr. Stauffer then took a position, on Aug. 3, 1870, as assistant engineer on the South St. Bridge, which the city of Philadelphia was then building over the Schuylkill River, with Strickland Kneass as chief engineer. At that time the use of compressed-air caissons for sinking foundations was unknown in this country, but had been practiced in France. Mr. Stauffer took up the study of French in order to post himself on what had been done in this field and be able to apply his knowledge to the construction of this bridge. At this time he wrote an article on "The Use of Compressed Air in Tubular Foundations," which was printed in the *Franklin Institute Journal* and was republished by the Institution of Civil Engineers of London. It was the first detailed description of compressed-air foundation work printed in the United States, and was used as a textbook for a time in some of the engineering schools.

The South St. Bridge cost $800,000, and its construction dragged along very unsatisfactorily owing to the difficulties of the work and the bankruptcy of the contractor. On June 27, 1874, Mr. Stauffer accepted a position as assistant chief engineer on what is now the Bound Brook Line of the Philadelphia & Reading R.R. between Philadelphia and New York, and was assigned to special charge of the Delaware River Bridge on that line. Meanwhile, the affairs of the South St. Bridge were still in suspense, and as the Bridge Commission would not accept Mr. Stauffer's resignation, he still retained charge, on full salary, of the adjustment of the Commission's differences with the contractor's estate until the final completion of the bridge in December, 1875.

On June 1, 1876, the Bound Brook Line being completed, Mr. Stauffer left the service of the Reading company and was for a time engaged in private work, making bridge plans for the Philadelphia Survey Department. In January, 1877, he was a candidate for city engineer of Philadelphia, but was beaten after a close fight. On Apr. 15, 1877, he entered the service of the Philadelphia Water Department as engineer in charge of construction. He built the Frankford reservoir and pumping stations and other important works, and also engaged in a certain amount of private engineering practice.

At the close of 1879, Mr. Stauffer ventured into the contracting field in partnership with R. A. Malone, a well known Pennsylvania contractor. The firm was awarded the contract for what proved to be one of the most difficult pieces of tunnel work that had at that time been undertaken, the Dorchester Bay Tunnel at Boston for the discharge of sewage. The tunnel was an inverted siphon about 9000 ft. long, with its bottom 180 ft. below sea level. One shaft was sunk through soft ground and quicksand almost its entire depth. The leakage through the rock roof into the tunnel was so great that the pumping plant was enormous and involved heavy expense.

The venture was a disastrous one for the contractors and would have been even more disastrous except for the discovery by Mr. Stauffer at the height of the difficulties that the seamy character of the rock through which the tunnel was to be driven was known to the city authorities, to some extent at least, but had not been made clear to the bidders on the contract. This led to a settlement which enabled the contractors to complete the work. By December, 1880, the tunnel was finished except the brick lining, and Mr. Stauffer, who had suffered several attacks of fever due to the conditions of living on the work, sold his interest in the contract to his partner.

Mr. Stauffer returned to Philadelphia and was for two years with the Philadelphia Bridge Works, owned by Cofrode & Saylor. He resigned his position in September, 1882, and removed to New York City, where he opened an office for private practice as an engineer, renting quarters in the Tribune Building from Geo. H. Frost, then publisher and sole proprietor of ENGINEERING NEWS. The acquaintance thus formed resulted in the purchase by Mr. Stauffer, in January, 1883, of a part interest in ENGINEERING NEWS, of which he became the editor. Of what Mr. Stauffer brought to the journal at that time, Mr. Frost himself has written in some unpublished reminiscences:

> The debut of Mr. Stauffer gave to the service of the paper a real engineer who was competent to decide upon the merits of engineering work of which we might be called upon to publish descriptions. Mr. Stauffer was well known and was already very popular where known; he was an expert draftsman and his industry in this line soon became apparent in the paper.

It was Mr. Stauffer's notable ability as an artist that first suggested to Mr. Frost the value of his services as an editor. Those who possess the back volumes of ENGINEERING NEWS for the years 1883 to 1887 will find there many sketches made by Mr. Stauffer. His work with pencil, pen and brush, in fact, although as an artist he was wholly self-taught, was all his life long a source of pleasure to himself and to his friends.

Until the advent of Arthur M. Wellington to the editorial staff in 1887, Mr. Stauffer was the editor-in-chief of ENGINEERING NEWS. With the coming of Mr. Wellington's forceful personality, Mr. Stauffer, with characteristic modesty, yielded the chief responsibility to his associate, though his conservative good judgment was a most valuable counterbalance to Mr. Wellington's enthusiasm.

His work as editor of ENGINEERING NEWS continued to some extent down to his final severance from the paper when he sold his interest in it some six years ago.

During the later years, however, numerous other interests made demands upon his time. In fact, while Mr. Stauffer, as may be gleaned from the above account, did conspicuously good work during his 18 years of activity as a civil engineer, his temperament was essentially that of the artist and literary man. At a comparatively early age he was even more widely known as an authority on antiquities and historical lore than as an engineer. He wrote himself of his work in this field:

> I was probably born a collector of "curios," commencing with coins and postage stamps. In 1876 I fell heir to the papers of a remote relative, who was a Chief Justice of the Superior Court of Pennsylvania and prominent in the Revolution. I found about two tons of papers stowed away and carefully preserved in his old house, and the "pickings" from this formed the nucleus for a valuable collection of Colonial

and Revolutionary autographic matter, numbering about 30,000 letters and documents. I then began gathering portraits to illustrate autograph letters; and about 1880 I commenced the private illustration of books, chiefly American and historical in character, by the insertion of portraits, views, letters and documents, and pen and ink and water-color drawings. A "History of Philadelphia," thus illustrated, now (1898) has about 18,000 prints, etc., inserted in it, and is said to be the most elaborately and profusely illustrated local history in the United States. In all about 40,000 prints, etc. are thus disposed of in my collection. Included is a "History of Engraving," illustrated by about 7000 examples of the work of 2800 different engravers, dating back to 1480, and including the etchings of many famous artists. There is also a unique collection of the works of American engravers and lithographers, covering the work of nearly 700 different men. Other items in my collection are old arms, rare china, rare books on America, etc.

I have made many of the illustrations for these books; and have designed about 50 book plates for friends; and am credited with being one of the first in America (1872) to introduce what is now called the "pictorial" style of bookplate.

In 1905 I wrote the first work ever published upon American engravers on copper and steel, accompanied by a descriptive list of about 3000 plates engraved by the earlier American engravers. This work was published by the Grolier Club, New York.

Without doubt Mr. Stauffer's collection of historical documents and relics was one of the most valuable and intelligently gathered in America. Begun in early life as a hobby and a relief from the active work of his profession, it became in later years an occupation which enlisted all his energies.

His Alma Mater, Franklin and Marshall College, gave him the degree of A.M. in 1881 and the degree of Doctor of Literature in 1904.

In March, 1891, Mr. Stauffer, as one of the editors of ENGINEERING NEWS, was invited to accompany the Warner Miller party to the Nicaragua Canal work. The party sailed from New York on the steamer "Aguan" and was shipwrecked on a coral reef in the Carribean Sea, near Roncador Island, on the voyage to Greytown. Among the members of the excursion party were the late G. Hilton Scribner, of Yonkers, N. Y., and his oldest daughter, Florence. The intimate associations in connection with the shipwreck and final rescue culminated in a romance and the marriage of Mr. Stauffer and Miss Scribner on Apr. 19, 1892. Their home in Yonkers has been the resort of a choice circle of friends and noted for its gracious hospitality.

The list of societies and clubs of which Mr. Stauffer was a member is a very long one, including not only the leading engineering societies, such as the American Society of Civil Engineers and the Institution of Civil Engineers of Great Britain, but famous historical societies and such bodies as the Loyal Legion. In the early volumes of the American Society *Transactions*, from 1876 to 1883 will be found some notable engineering papers from his pen.

Mr. Stauffer was always interested in public affairs as an engineer and a citizen. He was active in charitable and philanthropic works in Yonkers during the later years of his life.

He was appointed by Gov. Roosevelt as one of the members of the Palisades Park Commission at its establishment, which has had for many years the work of preserving the Palisades on the Hudson River from destruction. Mr. Stauffer was long the Vice-President and Treasurer of this Commission, the members of which gave their services without compensation, and have performed a most important public work.

No review of Mr. Stauffer's life could be complete without reverent and loving mention of his fine personality. He was a man who made friends all his life long. The gentle art of making enemies was one accomplishment of which he never learned even the rudiments. His genial, sunny disposition and his wonderful fund of reminiscence and anecdote made him a center of attraction in every circle. Those who were attracted by his outward manner were held to him in bonds of friendship when they came to know him intimately and appreciate his sterling worth as a man.

The Hudson River was finally closed to navigation on Feb. 6, after 317 days of open water, one of the longest periods on record.

A Broken Cross-head Guide on a locomotive drawing the Twentieth Century Limited of the Big Four Ry. was discovered when the train entered the station at Middletown, Ohio, in time to save a wreck. B. D. Butler, a member of "Engineering News" staff, at its Chicago office, was standing on the station platform at Middletown, waiting to take the train and caught a glimpse of the broken guide as the locomotive passed him. He ran up the platform and reached the locomotive just as the go-ahead signal was given and was unable to get the attention of engineer or fireman. He was fortunately able to reach the conductor and warn him before he train started.

Inductive Interference with Telephone lines by high-tension power lines is being studied by a joint committee authorized by the Railroad Commission of California. This committee is made up of representatives of the various transmission-line, electric-railroad and telephone companies in California, and of the Railroad Commission itself. It has undertaken a series of tests as a part of its investigation.

The Proper Method of Valuing Private Water-works for purchase by New York City is to be reported on by a committee appointed by Mayor Gaynor, as follows: Lawrence Godkin, Eugene H. Outerbridge and Nelson P. Lewis. The latter is chief engineer of the Board of Estimate and Apportionment. The companies involved supply various outlying sections of the city. What is wished of the committee is thus stated by Mayor Gaynor:

> What we particularly with your judgment upon is the method of valuing such companies for the purpose of taking them over by the city. The basis of such valuation needs to be considered and stated. For instance, it is easy to say that these companies are supplying water in sections of the city which are rapidly growing in population, and that, therefore, their net income will grow with the growth of population. But, on the other hand, we have to consider that all public-service corporations are subject to the State Legislature, and that it will be presumed that the Legislature would see that the rates were so regulated that not more than a proper return for the capital invested would be allowed. A variety of suggestions like this will occur to you as readily as to me.
>
> I have considerable anxiety about this matter and I shall be glad that you all serve on this commission, even at some inconvenience to yourselves.

New Slides in Culebra Cut, Panama Canal—On the afternoon of Jan. 16, the Cucuracha slide, located on the east bank of the canal again renewed its activity and by the morning of the 17th, the moving mass of material had completely covered all tracks in the canal, except one next the west bank, making five tracks in all covered and destroyed by the slide. A train of cars, standing at the two shovels which were excavating the toe of the slide, was caught by the rapidly moving material and two cars were derailed and buried. A new track was built around the toe of the slide and two steam shovels commenced digging the slide away before noon of the 17th.

This recent movement of the slide carried material to a greater distance across the canal than in any other case, except the original movement of the same slide in 1907. It is estimated that in all about 400,000 cu.yd. of material will have to be removed from this slide before the end of the present fiscal year.

On the night of January 19-20, the rock bluff, some 300 ft. in height, on the east bank of the canal, immediately south of Gold Hill, broke away at a distance of several hundred feet to the east of the canal, and a large part of the broken material moved into the canal, entirely covering all tracks to the east of the center line. The total amount of material in the broken rock portion is estimated at about 500,000 cu.yd.; but this bluff, which was quite flat on top, served to prevent the movement into the cut of a clay top-covering

several feet in thickness, which lay to the eastward of it, some of which will now undoubtedly move into the cut, so that it is estimated that the probable effect of the break just described will be to add not less than 1,000,000 cu.yd. to the amount which will have to be removed from the cut by means of steam shovels.

Immediately south of the recent break is the "Purple Hill" by which the moving clay of the Cucuracha slide was divided in two, and which has served very effectually, on account of its superior height, to hold back a large amount of top-covering, which would otherwise have come into the canal. There are indications that the "Purple Hill" has been weakened on its north face by this break, and should this small hill break away and come into the cut, it would probably release an amount of moving material, which would aggregate between 500,000 and 1,000,000 cu.yd. additional to that previously described.

A new slide has recently developed in the east bank of the canal, about 1000 ft. north of the suspension bridge. The amount of material in motion is estimated at 125,000 cu.yd., the greater part of which consists of rock. ["Canal Record," Jan. 22].

According to newspaper dispatches, slides involving 3,000,000 cu.yd. were moving into the cut on Feb. 7. It was stated, however, that these would not delay the opening of the canal.

A Passenger Train Derailment on the Houston & Texas Central R.R., near College Station, Texas, on Feb. 1, involved the death of the engineer and fireman and injury to four other persons.

At a Grade Crossing on the West Jersey & Sea Shore R.R., near Absecom, N. J., on Feb. 6, an automobile truck was struck by an express train and demolished and three men on the truck were killed.

While Placing a Large Gate Valve for a 42-in. water main at Detroit, Mich., on Feb. 4, one of the supporting timbers failed, allowing the valve to fall into the trench. Three laborers were killed and six badly injured in the accident, according to press reports.

A Sawdust Explosion in the box factory of the H. H. Sheip Mfg. Co., of Philadelphia, Penn., on Feb. 5, injured six of the employees, one fatally. A bolt falling among the cutters on a sawdust grinding machine is reported to have caused a shower of sparks that served to ignite the particles of sawdust in the air. Explosions of similar nature are of common occurrence in coal mining and have occurred also in flour mills, candy factories and other industries producing inflammable dust.

A Collision on the Boston Elevated Railway on Feb. 4, resulted in injuries to four passengers. The accident occurred on a long curve on Commonwealth Ave., Allston, and was an indirect result of a tie-up on the line, caused by an earlier derailment. There was apparently some misunderstanding of the temporary emergency orders so that two trains, one carrying passengers and the other empty, came together. The claim was made that because of the curve, the two motormen were not aware that they were on the same track until too late to avoid a collision.

A Loan Collection of prints and books on early railroading is on exhibition at the New York Public Library, through the courtesy of the owner, William Barclay Parsons. The period covered is from the development of Trevithick's locomotive in 1804 to the commencement of the line between Manchester and Liverpool in 1830.

PERSONALS

Mr. G. A. Mitchell, hitherto Master of Bridges and Buildings of the Grand Trunk Ry., at Toronto, Ont., has been promoted to be Superintendent of Bridges and Buildings.

Mr. J. T. Gillick, formerly Superintendent of the Chicago, Milwaukee & St. Paul Ry., at Aberdeen, S. D., has been promoted to be Asistant to the General Manager, at Chicago, Ill.

Mr. W. E. Higgins, Assistant to the General Manager of the Lackawanna & Wyoming Valley R.R., has been made Acting Vice-President and General Manager, succeeding Mr. C. F. Conn, resigned.

Mr. R. G. England has become associated with Mr. William G. Fargo, M. Am. Soc. C. E., Civil and Hydraulic Engineer, Jackson, Mich., as a member of the firm to be known as the Fargo Engineering Co., of Jackson.

Mr. W. E. Costello, Superintendent of the Central Vermont Ry., at New London, Conn., has resigned to become Superintendent of the Houston & Texas Central R.R., at Ennis, Tex. He is succeeded at New London, by Mr. J. McCraw.

Mr. Edward C. Heald, M. Am. Soc. C. E., formerly Chief Structural Engineer, Office of the Supervising Architect, Treasury Department, Washington, D. C., has opened an office at 1516 H St., N. W., Washington, as a consulting engineer.

Mr. P. C. Hart, former General Superintendent of the Chicago, Milwaukee & Puget Sound Ry., at Seattle, Wash., is now General Manager of the Chicago, Milwaukee & St. Paul Ry lines east of the Missouri River, with offices at Chicago, Ill.

Mr. A. G. Holt, M. Am. Soc. C. E., formerly Division Engineer of the Chicago, Milwaukee & Puget Sound Ry., at Spokane, Wash., has been promoted to be Assistant Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., with headquarters at Chicago, Ill.

Messrs. W. W. Huff, formerly Assistant Bridge Engineer of the Kansas City Terminal Ry., and E. B. Murray, formerly Chief Engineer of the Kaw Valley Drainage Board, announce the formation of the firm of Huff & Murray, Missouri Savings Bank Bldg., Kansas City, Mo.

Mr. John J. Lyons has been appointed Chief of the superintendent department of the Ceresit Waterproofing Co., Chicago, Ill. This is a newly established branch of the company, which will undertake to superintend waterproofing work done by contractors for architects or engineers.

Mr. Robert I. Randolph, Assoc. M. Am. Soc. C. E., whose resignation as Secretary of the Rivers and Lakes Commission of Illinois was announced in our issue of last week, has withdrawn his resignation, pending the reorganization of the commission under the new state administration.

Mr. Nathan B. Payne, Jun. Am. Soc. M. E., formerly Manager of the governor department of Manning, Maxwell & Moore, New York City, has been appointed Manager of Sales of the Davis-Bournonville Co., manufacturers of oxy-acetylene welding and cutting apparatus, New York City.

Mr. Clifford B. Moore, Assistant Engineer, Topographical Bureau of the Borough of Queens, New York City, has been promoted to Chief Engineer at a salary of $6000 per annum. Mr. Moore entered the city service in 1900 as a transitman with engineering staff of the Department of Finance.

Mr. Devoe P. Hodson, Municipal Court Judge at Buffalo, N. Y., has been appointed a member of the Public Service Commission of New York, Second District, at a salary of $15,000 per annum. Mr. Hodson's salary as Judge has been $3000 per annum. He succeeds Mr. John B. Olmstead, of Buffalo.

Mr. Shirley Baker, M. Am. Soc. C. E., for a number of years Manager of the pipe department of the Redwood Manufacturers Co., San Francisco, Calif., has been appointed Construction Engineer of the Panama-Pacific International Exposition, the plans for which are described on another page of this issue.

Mr. Samuel P. Senior, Assoc. M. Am. Soc. C. E., Engineer and Superintendent of the Bridgeport (Conn.) Hydraulic Co., has been promoted to be Vice-President and Chief Engineer. Mr. Senior graduated from Lehigh University in civil engineering in 1897. He was famous as a foot-ball player during his college days.

Prof. Thomas M. Roberts, Assoc. Am. Inst. E. E., has resigned his office as head of the electrical engineering department at Delaware College to become Chief Electrical Engineer of the Edison Storage Battery Co., Orange, N. J. Prof. Roberts was formerly Engineer at the Boston, Mass., office of the General Electric Co.

Mr. G. C. Jones, formerly General Manager of the Central Vermont Ry., has been made Vice-President in charge of construction, operation and maintenance, with headquarters at Montreal, Que. Mr. Jones was at different times General Superintendent of the Central Vermont Ry. and Division Superintendent of the Grand Trunk Ry.

Mr. Willis Ranney, formerly of Bartlett & Ranney, San Antonio, Tex., sailed from New York City, Feb. 8, for Barcelona, Spain, where he will become a member of the engineering staff of the Ebro Irrigation & Power Co., under Mr. F. W. Abbott, M. Am. Soc. C. E., Construction Manager fir the F. S. Pearson Engineering Corporation.

Mr. Walter E. Holland, Assoc. Am. Inst. E. E., Chief Electrical Engineer of the Edison Storage Battery Co., Orange, N. J., has resigned to become Research Engineer with the Anderson Electric Car Co., Detroit, Mich. Mr. Holland has been associated with the Edison companies for the past ten years. He is succeeded by Mr. Thomas M. Roberts, as noted elsewhere.

Mr. Leonard Goodwin, recently associated with the Boston office of Lockwood, Green & Co., Mechanical Engineers, Bos-

ton, Mass., has been appointed Manager of the Chicago office of the firm, in the First National Bank Bldg., Chicago, Ill. Mr. Harold V. Coes, formerly Manager at Chicago, has been transferred to the Boston office to assume charge of special work.

Mr. Arthur M. Shaw, M. Am. Soc. C. E., has resigned as Engineer and Resident Manager of the Phillips Land Co., New Orleans, La., to accept a similar position with the New Orleans Lake Shore Land Co. Prof. W. B. Gregory, M. Am. Soc. C. E., of Tulane University, is Consulting Mechanical Engineer for the company, whose offices are at 1003 Hibernia Bank Bldg., New Orleans, La.

Mr. Conrad D. Trubenbach recently with the Public Service Commission of New York, First District, and formerly connected with the Pennsylvania R.R. East River tunnel work, has become associated with Mr. Daniel R. Bacon, Assoc. Am. Inst. E. E., Consulting Engineer, 30 Church St., New York City. Mr. Trubenbach was also connected at different periods with the New York Central & Hdson River R.R., on its marine development work in New York Harbor and with the Rapid Transit Commission of New York City.

Mr. M. A. Long, M. Am. Soc. C. E., Architect of the Baltimore & Ohio R.R., Baltimore, Md., has been appointed Assistant to the Chief Engineer of the entire Baltimore & Ohio R.R. System. Mr. Long is in his 38th year. He received a public school education at Dayton, Ohio, and studied architecture through correspondence courses. He obtained a position in the architectural and engineering department of the Baltimore & Ohio R.R. in 1899, and was rapidly promoted to the position of Architect of the company within five years. Mr. Long is also a member of the American Institute of Architects and is Vice-Chairman of the building committee of the American Railway Engineering Association.

Mr. F. A. Gaby, Assoc. Am. Inst. E. E., who has been Acting Chief Engineer of the Hydro-Electric Power Commission of Ontario since the resignation of Mr. P. W. Sothman, M. Am. Inst. E. E., last July, has been permanently appointed Chief Engineer. Mr. Gaby graduated from the University of Toronto in 1903, and after several years with the General Electric Co. of Canada, as Erecting and Supervising Engineer, he went to Winnipeg, Man., where he was Assistant Engineer on the work of preparing the designs and specifications for the municipal hydro-electric plant, described in our columns in the issue of July 4, 1912. Mr. Gaby has been with the Ontario Hydro-Electric Power Commission since 1907, and was appointed Assistant Chief Engineer in 1908.

Mr. W. H. Penfield, M. Am. Soc. C. E., formerly Assistant Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., has been appointed Assistant to Vice-President David L. Bush, with headquarters at Chicago, Ill. Mr. Penfield began his engineering experience with the Buffalo, Rochester & Pittsburgh Ry., and was soon promoted to be Resident Engineer. He left this railway in 1899 to become Resident Engineer and later Locating Engineer of the Chicago, Milwaukee & St. Paul Ry. For three years, 1902-1905, he was engaged in location surveys for the Western Pacific Ry. in California, leaving this work in December, 1905, to join the engineering staff of the Chicago, Milwaukee & Puget Sound Ry. He was for several years Construction Engineer at Butte, Mont.; he was promoted to be Assistant Chief Engineer in 1911.

OBITUARY

Lloyd B. Fuller, a former Assistant City Engineer of Chicago, Ill., died at his home in that city, Jan. 29, aged 72 years.

A. J. Hanson, a pioneer Western railway contractor, died at his home in Longmont, Colo., Feb. 2, from paralysis. He was 70 years old. Mr. Hanson went to Denver in 1869 and for many years was engaged on contracts for building early Colorado railways.

James V. Welch, a well known Western railway contractor, who graded many miles of track in Oregon, Washington and British Columbia, died Feb. 2, at Port Arthur, Ont., where he was at work on a contract to build a section of the Canadian Northern Ry. He was 52 years old.

Fred L. Waterous, President of the Waterous Engine Works Co., builders of steam and gasoline fire engines, St. Paul, Minn., died at his home in South St. Paul, Feb. 4. He is said to have been a pioneer in the development of self-propelled gasoline fire-fighting apparatus. He was 58 years old and a native of St. Louis, Mo.

ENGINEERING SOCIETIES
COMING MEETINGS

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 17-20. Annual meeting in New York City. Secy., Joseph Struthers, 25 W. 39th St., New York, N. Y.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 19-20. Annual meeting at Boston, Mass. Secy., N. W. Gifford, Boston, Mass.

IOWA ENGINEERING SOCIETY.
Feb. 19-21. Annual meeting at Sioux City, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

IDAHO SOCIETY OF ENGINEERS.
Feb. 21-22. Annual meeting at Weiser, Idaho. Secy., I. F. Shaffner, Boise, Idaho.

ASSOCIATION FOR STANDARDIZING PAVING SPECIFICATIONS.
Feb. 24. Annual meeting at Pittsburgh, Penn. Secy., J. B. Hittell, 5917 Winthrop Ave., Chicago, Ill.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 25-26. Annual meeting at Indianapolis, Ind. Secy., W. F. King, Indianapolis, Ind.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 26-28. Midwinter Convention in New York City. Secy., F. L. Hutchinson, 33 W. 39 St. New York, N. Y.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Feb. 27-28. Annual meeting at Indianapolis, Ind. Secy., A. L. Neereamer, Indianapolis, Ind.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Mar. 3-5. Annual meeting at Chicago, Ill. Secy., W. P. Blair, 824 Engineers Bldg., Cleveland, Ohio.

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 11-12. Annual meeting at Urbana, Ill. Secy., Edward Bartow, Urbana, Ill.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Mar. 19. Annual meeting at Boston, Mass. Secy., S. E. Tinkham, 715 Tremont Temple, Boston, Mass.

UTAH SOCIETY OF ENGINEERS.
Apr. 18. Annual meeting at Salt Lake City, Utah. Secy., R. B. Ketchum, 702 Newhouse Bldg., Salt Lake City, Utah.

Indiana Sanitary and Water Supply Association—Several topics of broad engineering and public interest are to be discussed at the sixth annual meeting at Indianapolis, Ind., on Feb. 25-26, among them the following: "The Functions of a Technical Staff in Public Utility Regulation," "Industrial Contamination of the Public Water Supply," "Fire Waste and Fire Protection," and "Sewage Disposal."

The officers elected for 1913 are: President, F. C. Jordan; Vice-Presidents, D. R. Gwinn, H. E. Barnard, C. S. Woods, J. W. Elms and J. W. Peck; and Secretary-Treasurer, W. F. King.

American Institute of Mining Engineers—At the annual meeting, to be held at 29 West 39th St., New York City, Feb. 17-27, 1913, the principal item of the program will be a discussion of iron and steel, with main attention to metallurgy. An attempt will be made to bring out all available information on production of sound ingots. The iron and steel division begins its session at 10 a.m., Wednesday, Feb. 19, and will continue at 2 p.m., and possibly at 10 a.m. Thursday. The program includes the following papers, which will be available at the meeting in printed form:

J. R. Finlay, "Valuation of Iron Mines." Albert Sauveur, "Notes on Cast Iron." R. W. Hunt, "Comparison Notes on Steel Rail Rolling." H. M. Howe, "Why Does Lag Increase with Temperature from which Cooling Starts?" B. G. Klugh, "Microstructure of Sintered Material." F. L. Grammer, "Blast Furnace Slag Analyses for Twenty-four Hours." H. F. Miller, Jr., "Methods of Preparing Basic Openhearth Steel for Castings." B. Talbot, "The Production of Solid Steel Ingots." P. H. Dudley, "Piping and Segregation of Ingots of Steel and Ductility Tests for Openhearth Steel Rails." E. A. Beck, "The Use of Anti-Piping Thermit in Casting Ingots."

A general discussion of the subject of sound steel ingots, on behalf of both producers and consumers of steel, will be had, presented under the following topics:

1. Is the present method of getting rid of the pipe by cropping, a safe and reliable device for making sound steel?

2. Is it desirable to increase the amount of metal arbitrarily cropped off the top of an ingot, and, if so, what would be a fair excess price to pay for cropping off 20%.

3. Is it commercially practicable to make ingots without pipes or blow-holes, and what additional expense of manufacture would be justified to accomplish this result?

4. What process for making pipeless ingots seems the most promising of commercial success, and why?

The program of papers for the first technical session, 2 p.m. Tuesday, Feb. 18, has not been made public. In the sessions on iron and steel, the subject of sound ingots will be the first to be taken up.

ENGINEERING LITERATURE

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REVIEWS

British Works on Sewerage and Water-Supply

Reviewed by JOHN H. GREGORY*

THE MAIN DRAINAGE OF TOWNS—By F. Noel Taylor, C. E., Member of the Institute of Municipal Engineers; Author of "Civil Engineering Practice." Philadelphia, Penn.: J. B. Lippincott Co. London: Charles Griffin & Co., Ltd. Cloth; 6x9 in.; pp. xi+313; 350 text figures; 34 tables. $4.50, net.

"WATER SUPPLY" AND "DRAINAGE" SYSTEMATIZED AND SIMPLIFIED—By C. E. Housden, Late Superintending Engineer, Public Works Department, India, and Sanitary Engineer to the Governments of Burma and Eastern Bengal and Assam. London and New York: Longmans, Green & Co. Cloth; 5x7 in.; pp. 28; two folding plates. 60c., net.

The author treats mainly of the design and construction of sewers and sewage-disposal works. As the book has been written from the standpoint of an English engineer, English units and terms are used throughout.

In the first chapter the author considers Maps, Plans, Sections and Preliminary Arrangements and in the second and third chapters the Principles of Hydraulics and Hydrostatics and Practical Calculations.

Following these are chapters on Practical Construction, Forms of Sewers and Ventilation of Sewers. One chapter is devoted to Storm Overflows, Sea Outfall Manholes, Tank Sewers, Manholes, Lampholes, Flushing Tanks and Gullies, another to Pumping Sewage and still another to House Drainage.

In Chapters X and XI the author considers the Theoretical Side of Sewage Disposal and Sewage Disposal Works. The last chapter is devoted to Special Construction. The four appendices contain brief descriptions of the Dublin and Glasgow Main Drainage Works, of Sewage Measuring Appliances and Pneumatic Ejectors.

From a mere casual inspection one would expect the book to contain a large amount of valuable information, but this expectation is not borne out after a careful examination and reading of the subject matter. Many subjects of little importance are treated at great length and in great detail while but little space is devoted to much more important subjects.

That the author has spent a large amount of time in the preparation of the book is evident, but it is greatly to be regretted that much of the subject matter is not well presented. The book contains many statements with which experienced engineers will not agree, others which are open to question and still others which are incorrect.

The author's treatment of the subject of hydraulics and hydrostatics is laborious and far from satisfactory. Some of it is extremely difficult to follow, as formulas are used without stating what the different symbols stand for. Again, some of the formulas are incorrect. In the formula for weirs the author states that the discharge is in cubic feet per minute, whereas the formula gives the discharge in cubic feet per second. He then proceeds to simplify the formula by algebraic reduction and in so doing makes another error, leaving the reader with an absolutely incorrect formula.

Further on the author presents a formula for determining the mean thickness of a wall to resist water pressure and works out a numerical example. The head of water taken is 10 ft. and the author reaches the startling result that a concrete wall having a thickness of only 18 in. is required. The error occurs in the numerical work, which is given in detail on the page. It seems almost inconceivable that such an evident error should have been passed over by the author.

The author is very positive in his views. In treating of the pressure on a vertical plane, which is subject to water pressure at different levels on opposite sides of the plane, the formula presented is incorrect. The correct formula is easily derived and can be found in any standard textbook on hydrostatics. The author then undertakes to use this formula for computing the resultant pressure on a submerged hinged gate set in the bottom of a vertical wall with water at different levels on the opposite sides of the wall. Not only is the author's numerical work wrong, but his theory also is wrong as he has computed (errors excepted) the resultant pressure on the wall and not on the gate. Perhaps enough has been said to let the reader judge for himself as to the value of the chapter on hydraulics and hydrostatics.

On the separate system he says: "That such a system does not work well is clearly evinced by the small amount of attention it has had. The author can find absolutely no recommendations for it. . . . ." In the very next sentence he somewhat qualifies his views on the separate system, admitting that it has some advantages, but a little later he makes the statement: "It is also generally recognized that the sewage from a separate system is more difficult to treat than that from a combined system." Many engineers hold different views.

The chapters on the theoretical side of sewage disposal and on sewage-disposal works are also unsatisfactory. In the 73 pages devoted to these subjects the reader will search in vain to find any reference to some of the methods of sewage treatment which have come to the front in the last few years. But little is said of the Dortmund tank and no mention whatsoever is made of the Hampton tank or of the Imhoff tank. Few data are presented which are of practical use.

In conclusion it may be said that the book should be read with great caution, especially by a young and inexperienced engineer. That there is something of value in the book cannot be denied, but it is equally true that there is much in the book which is of little or no value.

Mr. Housden, in his "'Water Supply' and 'Drainage' Systematized and Simplified," has supplemented his "The Precise Calculation of Pipe Drain and Sewer Dimensions," noticed in these columns for Apr. 18, 1912, p. 765. In the present book the author presents a very ingenious diagram from which, knowing the discharge, length and available head, and after having made a very simple numerical calculation, the proper size of pipe to give the required discharge can be determined. The digram gives directly the diameters of clean pipes by Unwin's formula, and by means of a correcting scale, the use of which is explained, there are also given the diameters of incrusted pipes and of pipes corresponding to various values of "n" in Kutter's formula.

The author also explains how the sizes of two types of open drains can be determined by numerical computations. The process by which he arrives at the desired result is, however, not easily followed. The author further explains how the diagram and computations can be applied to small water-supply and drainage projects.

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A New Type of Steam Engine

Reviewed by L. S. MARKS.*

THE UNA-FLOW STEAM ENGINE—By Prof. J. Stumpf, Technische Hochschule, Charlottenburg, Germany. New York: D. Van Nostrand Co. London: Constable & Co., Ltd. Cloth; 8x11 in.; pp. 29; 250 illustrations. $3.50, net.

Fifteen years ago the reciprocating steam engine seemed to be crystallizing into its final shape. So long a time had elapsed since any fundamentally new features had been introduced that it seemed probable that the improvements in the steam-engine would be quantitative rather than qualitative, until some revolutionary discovery should be made. In particular it seemed that the only practical way of combating the ancient evil of cylinder condensation was by the use of jacketing, compounding, and superheating. Since that time, it has been found that both jacketing and compounding were being carried too far, and we have settled down to a period of moderate jacketing, two-cylinder compounding, and of considerable superheating.

The newly developed una-flow engine appears to be able to obtain the economy of a first-class modern engine without the use of compounding or superheating, and with very moderate jacketing. It is a prophylactic rather than a remedial method of meeting the cylinder condensation evil. In addition, it appears to offer other advantages. That it has commended itself to many European engineers is indicated by the fact that at the end of July, 1911, there were engines of this type with a total output for a half-million horse-power working or in actual construction. Furthermore, the engines in operation included stationary, locomotive, marine, portable, rolling-mill, winding and other kinds of engines. A book dealing with these new developments cannot fail to be of interest to all engineers who have to consider the problems of the generation of power.

This new type of engine has been devised and constructed by Professor Stumpf and his book is necessarily an ex parte statement of the case. It is the kind of material that is more generally published in the proceedings of an engineering society, or in an engineering paper than in book form. The bulk of the material and its importance justify the method of publication. The nature of the material makes it difficult for the reviewer to take any attitude towards it other than that provoked by a paper presented to a society.

For the benefit of those who are not as yet familiar with this engine it may be explained that it differs from the usual type in having a ring of exhaust ports around the middle of the length of the cylinder, in the manner which has become familiar since the introduction of the two-cycle gas or oil engine. Since the exhaust ports are covered after about one-tenth of the return stroke, compression takes place for nine-tenths of the stroke. This necessitates large clearance in non-condensing engines, except where the initial pressure is very high; in condensing engines, on the other hand, the clearance may be quite small. By the use of the central exhaust, the cooling action of the exhaust steam as it goes out of the cylinder in the usual counter-flow engine is avoided, and the variation in temperature of the parts exposed to steam is diminished. To assist further in keeping each part of the cylinder at a constant temperature, the cylinder heads and that portion of the barrel exposed up to cut-off are jacketed.

Starting with this central idea, an engine has been developed and designed which shows many unexpected advantages and great adaptability to all kinds of service. These matters are fully expounded in the book, and in addition there is given a large number of excellent drawings of actual constructions on this principle, together with the tests of some of them.

As the author remarks in his preface, "Expounding ideas is one thing—converting one's fellow men to a sufficient degree to influence them to carry out the ideas in practice, is an entirely different and very much more difficult thing." The author has been fortunate enough to convince many European engineers in a comparatively short time—one cannot but think that his difficulties would have been much greater had he tried to persuade the engineer of an American railroad to buy and test out a locomotive built from his plans.

The titles of the chapters of the book indicate the diversity in the use of the engine. After an explanation of the general thermal and constructional features, the advantage of the engine in the reduction of back pressure is brought out; the desirable degree of jacketing is discussed; the decrease in leakage and clearance losses is shown; the methods of taking steam for accessory steam-using apparatus are illustrated; and the influence of clearance volume on steam consumption is worked out at considerable length. In addition, eight separate chapters deal with as many different services for which the engine has been used and show how it has been designed, constructed and applied to each kind of service.

This book suggests one other book of its general class, namely, that in which Diesel discussed his engine. The two books differ, however, in this important respect; that whereas Diesel's dealt almost exclusively with the theory of his machine and with developments and applications which he proposed to make, Stumpf's touches but very lightly on theory but gives the results of practical experience with the machine.

*Professor of Mechanical Engineering, Harvard University, Cambridge, Mass.

A Study of Railway Rates

RAILROADS: RATES AND REGULATION—By Wm. Z. Ripley, Ph.D., Nathaniel Ropes, Professor of Economics in Harvard University. New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 6x8¾ in.; pp. xviii + 659; 41 maps and diagrams. $3, net.

As may be seen from the statement as to the size of the book and its number of pages in the heading above, this is a bulky volume. A good idea of its scope may be given by quoting the titles of some of its important chapters as follows: (I) The History of Transportation in the United States; (II) The Theory of Railroad Rates; (IV) Rate Making in Practice; (VI and VII) Discrimination; (VIII) Routing; (IX) Freight Classification; (XI) The Southern Basing Point System, Transcontinental Rates, Differentials, etc.; (XIII to XVIII) The Interstate Commerce Law of 1887, the History of Its Amendment and Execution with the various changes of the last half-dozen years; (XX) Conflict of Federal and State Authority.

The book represents an enormous amount of labor on the part of its author and contains a great amount of information on the subject of which it treats. Prof. Ripley is eminently qualified to write such a work from his experience as a teacher of economics, first at the Massachusetts Institute of Technology and in recent years at Harvard, together with his service as an expert for the U. S. Industrial Commission of 1901, and his extended studies of economic problems. The chief criticism we make of the book is to raise the broad question as to the practical usefulness of all this great mass of information to those who have to do with the actual fixing of railway rates, either as railway officers or in connection with governmental commissions.

Prof. Ripley himself confesses in his preface that he has used "an almost exuberant mass of illustrative material. Possibly, even, it may be alleged that in places so thick are the circumstantial trees of evidence that one can scarcely perceive the wood of principle."

If governmental control of rates is ever to bring order out of the present chaos, it would appear that we must have somewhat more of principle and method in the formation of railroad rates than has ever obtained; and in the determination of these governing principles, we shall not be helped much by the study of past history and past conditions. Neither must we consider alone what are present conditions, but we must look to the future. For example, one of the great problems in connection with railway rates at the present time is the amazing increase in the cost of handling freight in large city terminals and the equally amazing reduction in the cost of hauling over the road, when the train has once started on its journey.

Since rates must in the first place be based upon the cost of service, one might expect in a work of this sort to find some statement as to these costs and some reference to the proposals, already given consideration by railway officials, to make a separate charge for the terminal expenses of both passenger and freight traffic.

Prof. Ripley himself confesses in his preface that he has his bulky book, but he contents himself with what he well calls a rough estimate of fifty cents per ton for terminal cost with one-half cent additional per mile for movement expenses. As was shown in "Engineering News" some three years ago, under present-day conditions of trunk-line operation terminal costs in large cities are far in excess of the above amount, while the cost of haulage on the open road is far below it.

While the bulk of the book and the large space given to concrete examples may be criticised by the busy engineer or the over-worked railway commissioner who desires to make use of the book as a guide in his work, it is on the other hand true that the book is admirably adapted for use as a textbook and work of reference for students of economics. We recommend it also to students of engineering who desire to post themselves on the recent history of government railway regulation. In view of the amount of work which engineers are now called upon to perform in connection with

railway regulation, there can be no doubt that such educational training is of great practical value.

It is interesting in conclusion, as a significant illustration of how far we have traveled in modern economics since the "laissez faire" theory reigned supreme, 30 years or more ago, to have a professor in Harvard University express the opinion which we find set down in Mr. Ripley's preface as follows:

It is not unlikely, in my judgment, that the final solution of the so called Trust Problem in the United States, whether for good or ill, may ultimately contain as one important feature, the determination by governmental authority of reasonable prices for such prime necessities of life, as milk, ice, coal, sugar and oil, when produced under monopolistic conditions. This view is shared by my colleague, Professor Taussig, in his "Principles of Economics." It is also distinctly set forth by President Van Hise, of the University of Wisconsin, in his recent "Concentration and Control." When the seed of such an industrial policy is planted, as I believe it possible in time, the soil will have been richly prepared for its reception by our experience in the determination of reasonable charges for the services of railroads and other public utilities.

On Drawing

Reviewed by ROSSITER R. POTTER*

THE THEORY OF ENGINEERING DRAWING—By Alphonse A. Adler, M. Am. Soc. M. E., Instructor in Mechanical Drawing and Designing, Polytechnic Institute, Brooklyn, N. Y. New York: D. Van Nostrand Co. Cloth; 5⅝x9¼ in.; pp. xv + 312; 273 illustrations. $2, net.

ELEMENTS OF DRAWING—By George F. Blessing, M. E., Ph. D., Professor of Mechanical Engineering and in charge of Engineering, Swarthmore College; and Lewis A. Darling, E. in M. E., Engineering Department, Remy Electric Co., formerly Assistant Professors in Machine Design, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. xviii + 193; 151 text figures. $1.50, net.

THE PRINCIPLES* OF PARALLEL PROJECTING-LINE DRAWING—Part I of "The Theory of Engineering Drawing." By Alphonse A. Adler, B. S., M. E.; Instructor in Mechanical Drawing and Designing, Polytechnic Institute, Brooklyn, N. Y. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. vi + 66; 48 text figures. $1, net.

The difference between the "Theory of Engineering Drawing" and other books on descriptive geometry arises chiefly from an effort to present the subject wrong end first. At it is explained in the preface, "the order of presentation is reversed" and the reader is asked to consider first some concrete object, in fact a box, instead of "that most abstract of all abstractions," the mathematical point. There is little question but that the box is considerably more concrete than the point, and it may have a more tangible interest at the start for the young student. However, this advantage is more than offset, in the reviewer's opinion, by an inseparable difficulty—namely, the greater complication in the projection of the box as compared with that of the point. This is especially true here since the author has chosen to start in with oblique projection. To present the descriptive geometry of oblique projection as an introduction to the study of the more usual orthographic variety seems certainly a reversed method of teaching.

After the three opening chapters devoted, respectively, to oblique projection, orthographic projection and axonometric projection, the book settles down as a more or less orthodox textbook on descriptive geometry. A lingering trace of insurgency is manifested in the presentation of the projection of the line before that of the point. There should be some advantage in the explanation of the elements of mechanical drawing in connection with the principles of descriptive geometry, as it may help to impress upon the student the connection between them.

A device worthy of note is the repetition on successive pages of the figures referred to in the text on both those pages. This avoids the awkward inconvenience of reading the other side. A possible danger to be avoided in this method is brought out on p. 66 where the drawing for Fig. 53 is reproduced by mistake and marked Fig. 50, which latter figure it was apparently intended to repeat from the previous page.

Part III presents the principles of perspective projection, and the following section deals with "Pictorial Effects of Illumination," a somewhat obscure title for shade lining, shades and shadows. The style of the text throughout the book is occasionally loose and often involved, and the wording is less simple than is desirable in a book of this sort.

The authors of "Elements of Drawing" are or have been members of the faculty of Cornell University and the work outlined is based on the drawing-room courses required of first-year engineering students of that institution. As compared with other college textbooks in elementary drawing, this volume has a large amount of space given to instruction and advice concerning the choice and use of drawing materials and instruments. Considering that the opinions given on the best form and type of each particular instrument will have all the weight and authority of a faculty utterance, it seems plain that the authors have been too positive in some of their statements.

Some 35 pages are devoted to the subject of lettering. Freehand lettering is taught by the method of indicating the sequence of the separate penstrokes by means of numerals and the direction of each stroke by an arrow. About the same amount of space is devoted to freehand and isometric sketching, including the use of cross-section paper and paper with isometric ruling.

The models selected for illustration and as exercises for the student are the parts of a wood-turning speed lathe of the type commonly used for instruction in wood turning in engineering schools. The authors maintain that since the student will be taking his course in wood turning at the same time with his elementary drawing, he will take a more intelligent interest in these than in models of "the kindergarten type" or machine parts selected at random.

Under the title of "Principles of Parallel Projecting Line Drawing" there is published in a separate volume, Part I, of the same author's work on "The Theory of Engineering Drawing." It is intended as a text for preparatory schools or high schools. Oblique projection, orthographic projection and isometric, dimetric and trimetric projection are covered with the emphasis on the descriptive geometry involved rather than the technic or detailed method of making the drawings.

A Contribution to the Art of Locomotive Design

TESTS OF A JACOBS-SHUPERT BOILER—A Report by W. F. M. Goss, Dean, College of Engineering, University of Illinois, Urbana, Ill. Coatesville, Penn.: Jacobs-Shupert United States Firebox Co. Cloth; 8x11 in.; pp. 171; 112 text figures.

Judged from its title alone, the book before us might be classed with so called trade literature, since it is a report upon tests of a patented type of locomotive boiler, made for the purpose of demonstrating its advantages over boilers of the ordinary construction. The tests were made, however, under the direction of an engineer who ranks among the highest authorities in the field of locomotive engineering. Furthermore, the book, as indicated by the dimensions given above, is a bulky volume and covers a much broader field than merely the report of the tests.

The first two chapters of the book are devoted to a brief historical review of locomotive boiler development. Then follows a chapter describing the Jacobs-Shupert boiler, which gives a very clear exposition of the distinguishing features of its design.

As many of our readers may recall, the Jacobs-Shupert boiler was described in this journal in the spring of 1909 when the first locomotive equipped with it was put into service on the Atchison, Topeka & Santa Fé R.R. About 150 locomotives equipped with this boiler are now in use on the Santa Fé, and its use is extending on other railways.

Professor Goss devotes an interesting chapter to the results of a five-day investigation into the condition of locomotive boilers equipped with this type of firebox, which had seen extended service on the Santa Fé. Next comes a description of the program of tests which were planned to enable a comparison to be made of the relative merits of the ordinary boiler and the Jacobs-Shupert boiler. The tests were most elaborate in their character. In fact, it is doubtful whether a more complete experimental investigation of the operation of locomotive boilers has even been carried out in the whole history of railway engineering.

The spectacular part of these tests was the attempt to explode each of the boilers by allowing the water level to fall until the crown sheet was dry. These tests were made on June 20 last in the presence of a large delegation of railway officers from the American Railway Master Mechanics Association and a crowd of spectators numbering several thousand. The general result of these low-water tests, as reported at the time, in these columns, was the the failure of the radial stay boiler when the water had dropped about 15 in. below the crown sheet. About half the crown sheet came down, the escaping steam lifted the rear end of the

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boiler from its foundation, and scattered the brick work in which it was set in all directions over a radius of 150 ft.

In the Jacobs-Schupert boiler, on the other hand, the water continued to recede in the boiler until it had fallen nearly 40 in. below the crown sheet. The tubes, which were above water level, became overheated and sagged, and several collapsed; but notwithstanding the high temperature to which the firebox of the Jacobs-Schupert boiler was exposed it was practically uninjured by its severe treatment, and neither explosion nor collapse occurred.

Turning again to the other features of locomotive engineering treated in the volume before us, we may refer to chapters in the book discussing water circulation in locomotive boilers, the brick arch as a factor in boiler performance, and the relative value of firebox heating surface and tube heating surface. The latter subject, especially, is one on which authoritative data for the use of locomotive designers have long been much needed.

The concluding chapter gives a brief summary of all that has preceded, and enables the busy reader to obtain with the least expenditure of time a clear idea of the results which were obtained from this elaborate test, upon which many thousand dollars were expended.

High praise must be awarded to those in charge of the Jacobs-Schupert Boiler Co. for their enterprise in undertaking so elaborate and costly a series of tests to demonstrate the value of the important invention which they control. High praise must be awarded also to the distinguished author of the report for the care and completeness with which all the facts are stated, so that the expert engineer can study the data and form his own conclusions if he desires. At the same time Dr. Goss has clearly expressed his own opinions and conclusions, and his high reputation as a careful and impartial investigator will give these full weight of authority with engineers.

If there is any serious objection that can be made to the design of the Jacobs-Schupert boiler, it has never been brought to our attention. As for the inherent defects of the present type of locomotive boiler, their cataloging would make a lengthy list. It has long been recognized that in the design of stationary steam boilers stay-bolted surfaces are highly objectionable. But their use has continued with the locomotive boiler because no better method of construction has been developed. Certainly, then, the design of a locomotive boiler, which eliminates a large part of the stay-bolts, is a mechanical triumph of the highest rank.

Precise Measurements

THE THEORY OF MEASUREMENTS—By A. de Forest Palmer, Ph. D., Associate Professor of Physics, Brown University. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. xi + 248; illustrated. $2.50, net.

Centering around the theory of least-square adjustment, or, in other words, around the theory of accidental errors, there is a large group of considerations on precision of measurement and transmission of error, which require study jointly. Prof. Palmer has done original thinking in expounding these matters and linking them together in a unified treatment. The subject is not restricted to adjusting series of observations and obtaining an index of the consistency of the individual observations, but covers also the criticism of measurement methods and selection (by calculation) of the methods best suited to the desired grade of results. The book leads up to this point, and shows by some interesting problems how to make these applications to selection of method of observation.

As a well planned and well written treatise for the scientific laboratory investigator, the book will have a permanent place, besides doing present credit to author and publisher. As an engineer's book its position is not so assured, since it is written for the higher physics student and (in large measure) from the laboratory standpoint. The illustrative cases are nearly all from physical laboratory work. The subject, however, bears also on engineering work, not only in geodetic measurements but also on other operations in which series of determinations are involved, as, testing laboratory work. In fact, many matters which appear to involve complete certainty, such as design of structures, are really dependent upon considerations of probability and the combination of accidental errors.

Not only here, but just as much in geodetic work and physical-laboratory measurements, the question of discriminating between systematic and accidental errors may be closely tied up with the methods of observation employed. What under one method of measurement are accidental errors may by another method be separated into parts, of which one can be eliminated by arranging the procedure properly, while the other part remains fortuitous. This is suggested in the text, but is not emphasized.

Physical relations concerning which measurements are made are usually known from theory. Many observations in engineering are made before it is known that a definite relation exists between the initial and final quantities involved, and the results are expected to show whether a fixed relation exists. Graphical charting of results is most commonly used in this work. The procedure employed herein affords opportunity for much instructive discussion. The subject is discussed (but not exhaustively, nor sufficiently for the needs of the subject) in the final chapter of the book, entitled "Research." This is a particularly interesting chapter.

Covering least-square adjustment as well as the associated considerations, the book is of such broad scope as to merit a place in every scientific library, and in the libraries of many engineers.

A British Metallurgy of Iron and Steel

Reviewed by WILLIAM CAMPBELL*

AN OUTLINE OF THE METALLURGY OF IRON AND STEEL—By A. Humboldt Sexton, Emeritus Professor of Metallurgy, Royal Technical College, Glasgow; Past-President West of Scotland Iron and Steel Institute, and J. S. G. Primrose, Lecturer on Metallurgy, Royal Technical College, Glasgow; Member of Iron and Steel Institute, London. Second Edition. Manchester: The Scientific Publishing Co. Cloth; 5½x8¾ in.; pp. xv + 572. 12/6 net.

This book is divided into 44 chapters and the subject matter is arranged in the manner usually found in textbooks on the metallurgy of iron and steel. First are given the physical and chemical properties of iron and its compounds, then the various ores and their occurrence are discussed in Part I. Under the heading of Part II—Iron, the properties, etc., of pig iron and its production in the blast furnace are dealt with in some detail, ending with a chapter on the foundry. Part III is devoted to malleable iron and puddling, while Part IV embraces steel: The crucible, bessemer and openhearth processes; the working and casting of mild steel; alloy steels; testing; rusting and protection; microstructure; heat treatment, and ends with an appendix of miscellaneous subjects.

Taken as a whole we are given a very clear outline of the subject, which is well written. As is to be expected, the book is from the British standpoint and necessarily British methods are those on which great stress is put. Where American methods or figures are given they are for the most part old. As examples of this, the following may be noted: The diagram of the iron and steel industry (p. 7) shows crucible steel as the product obtained by melting blister steel, whereas today in this country most crucible steel is made from "melting-bar," an openhearth product. The bloom from puddling is hammered, not squeezed. For blast-furnace gases a long column shows the purification of the liquids, but for the gases the use in gas engines does not appear on the diagram.

Under the heading of iron ores, the Lake deposits are just mentioned while the iron ores of Spain are given almost a page—though under Geographical Distribution analyses of ores from the Lake Superior region are given. The analyses are evidently old, for the Vermilion range is given as 65% iron; the Mesabi as 63 and the Marquette as 61½%.

Some space is devoted to the British ore supply; imports; fluctuations in British ore and pig-iron production; prices of British pig irons, May 26, 1911; fluctuations in price of Cleveland pig, 1875-1910, and so forth.

In the section on blast-furnace practice in the United States of America, there appears:

> The iron production of the United States is now so large and is spread over such a wide area, with such varying conditions, that the practice must vary considerably. Hematite pig is made in districts where ores free from phosphorus occur, in other localities foundry pig is made. Coke is the fuel almost always used, but anthracite and charcoal are used to a smaller extent. Raw coal, suitable for direct furnace use, occurs, but has not yet been utilized.

"American Bloomeries—Howe describes a hearth as still in use in the United States for the direct production of malleable iron," would read better "Howe described in 1891, etc." Under the heading of Carbon Content of Steels, page 223, hard rails are given as carbon 0.35 to 0.50%. Similar criticisms apply to the sections describing the various processes of steel making.

Discussing blister steel, mention is made of Arnold's work on the microscopic study of the Cementation Process, in which Fe_3C was thought to play an important part. This seems to complicate unnecessarily a fairly simple phenomenon.

The two sections of the book most open to criticism are

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those dealing with microstructure and heat treatment. The method given for the preparation of specimens for microscopic examination is not the best. It is recommended to cut specimens ½-in. cube. In practice, it is generally better to have the thickness about half the width in order that the finished surface may be perfectly flat. For etching it is stated that picric acid in alcohol is very useful in some cases, especially when phosphorus is present. It seems the general opinion that picric acid is the best etching medium for general work. Again, it is recommended to wash the specimen with water, lime water and again with water or alcohol and finally dry with a current of air; whereas, the specimen ought to be given a final wash with alcohol to prevent rust and stain; also, mopping with a very soft linen handkerchief is much more convenient than an air current.

It is stated that when pure carbon steels with more than 1% carbon are very slowly cooled from 1000° C., a portion of the carbide is decomposed and an equivalent of carbon is set free in the form of annealing carbon. We know that high-carbon steel worked at a low temperature, cold rolled or in small sections often shows this; but the fact that we can get dead soft steel with no free carbon by heating to high temperatures and very slow cooling shows that such precipitation is the exception rather than the rule.

The iron-carbon diagram, on page 507, shows ferrite, graphite and cementite below Ar_1. According to the phase rule only two phases are in equilibrium, hence this cannot be the stable diagram. It would be much better to give the double-diagram showing the stable and metastable systems, following Heyn, Benedicks and the others. Surely Upton's diagram is at least worthy of mention.

Again, under the heading of quenching, on page 528, the best temperature for quenching any steel is given as just above the lower boundary line of the area of region III, which is the liquid + plus primary graphite, evidently a misprint for region IV. This would hold good for steels of 0.9% carbon or less, but above that, quenching ought to be done from just above the lower critical point, that is, Ac_1. We are also told that suitable tempering is often able to restore the requisite fine grain (in a brittle and coarse-grained steel). Surely tempering merely changes hardness, but never affects grain size.

In conclusion, while the book has many points to recommend it to the British student, as an elementary textbook, Stoughton's "Metallurgy of Iron and Steel" covers the ground and is more suitable for American readers. The make-up of the book is excellent, printing and binding are very good and the illustrations exceptionally clear.

Factory Planning

ENGINEERING OF SHOPS AND FACTORIES—By Henry Grattan Tyrrell, C. E., Bridge and Structural Engineer; Author of "Concrete Bridges and Culverts," "Mill Buildings," "History of Bridge Engineering," "Artistic Bridge Design." New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. xvii + 399; 174 text illustrations. $4, net.

The author has been known more in connection with bridge and structural work than for work in factory planning. It will not surprise the reader therefore to discover that the present book is strongest on the structural design of factory buildings. It contains also some chapters on location and planning, and on certain items of equipment, such as heating and lighting, air washing, sewerage, etc. But in examining these chapters it becomes evident that the subjects are not the author's own, and that in compiling he has missed completeness and in many instances correctness. This no doubt reduces the value of the book. Yet the work forms an ample collection of suggestions, remarks, descriptions and data on various phases of factory planning, and as such it can prove useful and valuable on many occasions.

The author begins with the relation of the engineer to factory design, and gives standard rates of charging. He discusses questions of location and general layout, and gives in detail a report on a proposed bridge shop. The factors of the structural design, and the types and details of the design itself, are then entered into; here wood, steel and concrete as main materials, and the components such as foundations, floors, partitions and roofs, are treated. Certain special building types and special structures (bins, chimneys, tanks) are discussed separately. Individual chapters on heating, lighting, water-supply, fire protection, air washing, sewerage and cranes, follow; but as already noted these must be read with constant caution, and they are chiefly useful in a suggestive way. Some concluding chapters, giving (among other things) sample estimates, weight tables of steel sheds, and the inevitable discussion of "welfare" features, should also be noted.

The book is quite fully illustrated. The selection of illustrations is affected somewhat as is the text, the structural-steel field being greatly favored and many other subjects represented poorly in quantity or nature of illustrations. But the execution of the illustrative matter deserves commendation, being in most cases remarkably good, which comment applies also to the typography.

An Exposition of Municipal Government and a Survey of Ten Commission Plan Cities

THE NEW CITY GOVERNMENT—A Discussion of Municipal Administration Based on a Survey of Ten Commission Governed Cities. By Henry Bruère, Director of the New York Bureau of Municipal Research. William Sheperdson, of the Staff of the Bureau of Municipal Research, Cooperating in the Collection and Tabulation of Material Respecting Commission Government. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. xiii + 438; 10 folding plates. $1.50, net. $1.62, postpaid.

Here are virtually two books woven into one; an exposition of what constitutes efficient municipal government and a report on a "survey" of ten commission governed cities. The "survey" was limited to two or three days spent in each city, but was made to yield more than might be expected from such brief visits by going around with an already prepared schedule of questions, to which answers were sought. The information thus obtained was supplemented by official documents, and the whole, it is to be supposed, was arranged and studied at comparative leisure.

The presentation and discussion of the data secured by the "survey" both gain and lose by being combined, and in some cases one might say mixed, with an exposition of the principles of municipal government as conceived by the New York Bureau of Municipal Research. For those who have no ideas of their own as to what efficient municipal government is, there may be a gain in this dual presentation of the results of the survey and of a theory of municipal administration. However, since the authors chose this dual plan, the results are to be judged accordingly, though it is, of course, permissible to say that the plan has great drawbacks for all except elementary students of the subject and, perhaps, for most of those.

The cities chosen for study were Cedar Rapids and Des Moines, Iowa; Kansas City, Topeka, and Wichita, Kan.; Dallas, Fort Worth, Galveston and Houston, Tex., and Huntington, W. Va. The population of these cities ranges from about 30,000 for Huntington to 92,000 for Dallas. The general plan of the "survey" was to use a score card for recording "two general groups of facts": (1) Those relating to streets, parks, homes, factories, public buildings and grade crossings, or "physical condition of the city," and (2) those relating to "common services," which include hotels, various recreation facilities, railroads, street cars, water and other utilities. So far as the book is concerned, the results of the "survey" are presented largely in the form of comparative tables. In addition, some descriptive text is given and comments and criticisms, of course, are also in the form of text.

After outlining "new standards of city government" the authors describe the general purpose and methods of the "survey." They next take up "the commission government movement," and, after that, the "efficiency movement." Then follow chapters on accounting and reporting methods, budget making, supply purchasing and store keeping, the administration of public works, the protection of persons and of property, the protection of life and health, civil service and related matters. All these chapters carry out to a greater or less degree the dual plan already mentioned of trying to outline the principles of municipal administration with the report of the "survey" of the ten cities. Two other chapters following somewhat the same general plan deal with attempts to make municipal government efficient by means of charter changes and with "citizen control and coöperation." An appendix outlines a plan for what is termed "representative health organization and work."

The book is strongest, as might be expected from the composition of the Bureau of Municipal Research and the sort of work it has done in the past, on its accounting and budget-making side, and in its dealings with some of the general problems of municipal efficiency. Next, perhaps, in strength is the section on health administration. Weakest of all is the discussion of public works and engineering. Waterworks are passed by with scarcely a mention, and do not appear to be given any place whatever in the index.

Since so large a part of the work of our municipalities is concerned with public works and engineering, it is obvious that for a really thorough-going "survey" of results obtained under the commission plan of government, or for that matter under any other plan, the coöperation of an engineer, would be advantageous. The book bears no evidence of such co-operation.

As the book stands, it contains many comparative data on the municipal organization of the ten cities studied, and apparently fewer data on actual achievements. These data are well presented in tabular, graphical and other forms, and many useful deductions and suggestions are based upon them. The viewpoint is that of the investigator rather than the administrator of municipal affairs, and of the accountant rather than the engineer. Strong emphasis is laid on service rendered to the citizens as a standard for judging the successes or failures of municipal government, and efficiency is the keynote throughout.

The net conclusions drawn from the "survey" is that commission government in the cities studied is an improvement over the forms which preceded it, but chiefly in organization, the placing of responsibility and giving an enlarged measure of popular control. "It is not a method," the authors say, "except as to election, recall, legislation," and "it does not make graft impossible because it does not in itself provide means for detecting graft in contracts, job loafing or padded payrolls"; and it "leaves practically unaffected 50 per cent. of official acts."

Electrical Machinery Estimating

Reviewed by V. KARAPETOFF*

DIE VERANSCHLAGUNG ELEKTRISCHER LIGHT UND KRAFTANLAGEN unter Benutzung vorgedruckter Formulare. By B. Jacobi. München and Berlin: R. Oldenbourg. Cloth; 6½x10¾ in.; pp. vi + 207. 7 marks.

The book consists of 20 printed forms for estimating prices on various kinds of electrical machinery, apparatus and aggregates, delivered and installed. The following estimates comprise the book: Direct current generators with auxiliary apparatus; switchboards for a direct-current power house; alternating-current generators with auxiliary apparatus; switchboard for an alternating-current power-house; storage-battery with necessary connections and switchboard; direct-current boosters; protective apparatus against over-voltage; aërial transmission line; cable network; transformers with auxiliary apparatus; direct-current motors with starters, wiring and auxiliary apparatus; induction motors; distributing switchboards; electric lighting installation with incandescent and arc lamps; wiring for a lighting installation; rotary converters. The estimates are given in great detail, some forms comprising over 60 items.

In each estimate the author begins by specifying the principal pieces of machinery or apparatus, leaving blank spaces for the rating, the number of units, etc. Space is also left for specifying exactly the type of apparatus, for instance, series, shunt, or compound wound, hand-operated or motor-operated, etc. Then he enumerates the secondary parts, such as foundation-bolts, knobs, wire, porcelain tubes, then follow solder, tape and minor materials; also packing and freight, and finally the labor of installing. All items not specifically included are mentioned separately at the end of each estimate. No prices are given for the reason that each estimate form is suitable for widely different sizes and types of apparatus. The prices are supposed to be taken from available quotations and catalogs. In some cases the author gives a hint for estimating the cost of auxiliary apparatus. The purpose of the work is to make all estimates originating in an office uniform, to save time and to make sure that no important items have been omitted when the estimating engineer is rushed with work.

A valuable part of the book is the explanatory matter and the notes which are appended to each form. In these explanations factors are indicated to guide the contractor in the selection of a particular type or size of apparatus. In some places the author also briefly explains the function of various types of machinery and apparatus, so that even a person not electrically trained can intelligently follow the estimate or can make an estimate himself in a standard case. Similar works for various branches of civil and mechanical engineering have been in use abroad for many years, and the author has rendered a valuable service to the electrical profession by compiling these forms for estimating electrical contracts.

It is only natural that a work on electrical estimating should appear at a comparatively late date, first because the profession itself is a new one, and, secondly, because it is only a few years since safety regulations in electrical installations ceased to be changed to any extent. Almost each country has a set of rules for electrical installations similar to our Fire Underwriters' Rules and the Standardization Rules of the American Institute of Electrical Engineers. The existence of such rules makes it possible to use uniform specifications and estimates in standard cases. Mr. Jacobi's work will be useful for manufacturing, consulting, construction engineers, and contractors, and also to those who wish to become acquainted first-hand with the modern electrical practice, by reading the explanations which accompany the forms. For German readers these forms are available printed separately for office use. It is hoped that the book will be translated into English, or that a similar work will be published in this country for the use of American electricians. Like most German books, Jacobi's work is very carefully written, the explanations are clear, and the type and the general appearance of the book are quite satisfactory.

THE FREEZING-POINT, BOILING-POINT AND CONDUCTIVITY METHODS—By Harry C. Jones, Professor of Physical Chemistry in The Johns Hopkins University. Second edition, completely revised. Easton, Penn.: The Chemical Publishing Co. Cloth; 5¼x8 in.; pp. vii + 75; 15 text figures. $1.

The time is fast passing when it is generally considered sufficient to study chemistry entirely from a chemical standpoint, physics only from a physical standpoint or mathematics from a purely mathematical standpoint. These three sciences are perhaps more fundamental than some of the others, and to a certain extent they are distinct, but they are nevertheless closely enough allied so that any study of either of them, which does not embrace an investigation of the bearing of the other two upon it, must necessarily be limited in scope.

Two of the most common and perhaps the most interesting effects observed, on the borderland between chemistry and physics, are the lowering of the freezing-point and raising of the boiling-point temperatures of a solvent, produced by a dissolved substance, and the change in conductivity of solutions of electrolytes at different stages of dilution. These effects are treated in this book in their relation to the laboratory study of physical chemistry, an effort being made to avoid the usual extremes of a too involved theoretical discussion, or of a mere description of the apparatus and directions as to the practical points involved in its use. The author has chosen what he considers the salient features of the problem, both theoretical and practical, and covered them clearly and simply. The mathematics used have been reduced to a simple form and explained thoroughly.

Those portions of the text in which the "ionization theory" is involved may be open to some difference of opinion in the present state of knowledge of that subject, however they are probably an element of strength rather than weakness in the book, as any opposition to this theory, which may be raised, will tend to bring us a step nearer to the actual truth of the matter. The "ionization theory," although it contains some weak spots, does appear to offer at least a partial explanation of many phenomena observed in this field of research.

A lamentable feature of the book (and by no means an uncommon failing in technical works) is the entire absence of any graphical representation of the relations involved in the problems covered by it. Through years of study of the subject, the author no doubt has these relations clearly and indelibly fixed in his own mind, and not necessarily in a graphical form, but to the large number of readers who could find interest and profit in the book, without having the same intimacy with the subject, these relations could be much better and more quickly explained by a few curves, than by pages of written matter, equations or statistics.

In regard to the above criticism it is only fair to say that the book gives a large number of references to other literature on the subject so that any one particularly interested in the problem can find more extended treatment of the various points of importance, elsewhere.

THE MODERN GASOLINE AUTOMOBILE: ITS CONSTRUCTION, OPERATION, MAINTENANCE AND REPAIR—A Practical, Comprehensive Treatise Defining All Principles Pertaining to Gasoline Automobiles and Their Component Parts. By Victor W. Page, M. E., Late Technical Editor of "The Automobile Journal." New York: The Norman W. Henley Publishing Co. Cloth; 5½x8¾ in.; pp. 693; 380 text illustrations; numerous charts. $2.50.

It has been said that the boys of the nineteenth century, or rather of the last three-quarters of it, derived most of their knowledge of mechanical engineering from the loco-

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motive. It is almost needless to say that to the boys of the twentieth century the automobile has taken the place which the locomotive held fifty years ago. As a result of the enormous development of the automobile, the gasoline engine is better known to the present generation than the steam engine.

There has been a profusion of semi-popular books published upon the automobile, but most of these books have been of comparatively limited scope and quite elementary in their treatment. The book before us bears every evidence of having been compiled and written with painstaking care and with a thorough knowledge of the subject in every phase. As the title indicates, the author has confined himself to the gasoline automobile exclusively, omitting all mention of electric and steam driven machines, and no space is devoted to the historical matter which books of this sort usually contain. Little attention is given, too, to the variety of types of car and motive power which were quite common half a dozen years ago. The author has confined himself to the design, construction and operation of the motor cars built for either pleasure or commercial use at the present day, and he has treated this subject exhaustively.

While the book is written in nontechnical language, it goes into much detail with respect to questions of design and aims to cover the main variations in type which still exist in automobile details. The style of the author is clear, and the work is well arranged. The illustrations in the book deserve especial praise. The publisher's work on the book has also been extremely well done, and it is sold at a reasonable price.

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Differential Calculus

Reviewed by ARTHUR D. BUTTERFIELD*

THE A B C OF THE DIFFERENTIAL CALCULUS—By Wm. Dyson Wansbrough, Author of "The Portable Steam Engine: Its Construction and Management," "The Proportions and Movement of Slide Valves," "Modern Steam Boilers." Third edition. New York: D. Van Nostrand Co. London: The Technical Publishing Co., Ltd. Cloth; 5x7¼ in.; pp. xii + 148; 30 text illustrations; $1.50, net.

The fact that this book has appeared in a third edition, with but slight changes, testifies to a demand for a simple presentation of the fundamentals of the differential calculus in a style as free from technicalities as possible.

The attempt of the author to present the fundamentals in a less rigorous way than usual has resulted in a large amount of unnecessary work in some cases, with several glaring inaccuracies. For instance, probably the most fundamental idea of the differential calculus is that if $f(x)$ and $F(x)$ are functions such that $f(a)=0$ and $F(a)=0$, then $\frac{f(a)}{F(a)} = \frac{0}{0}$ is meaningless, but $\lim_{x=a} \frac{f(x)}{F(x)}$ may be and usually is wholly definite. As a matter of convenience $\frac{f(a)}{F(a)} = \frac{0}{0}$ is usually defined to mean simply $\lim_{x=a} \frac{f(x)}{F(x)}$. This idea the author has seemingly failed to grasp, and leads the reader, in the first chapters, through a maze of entanglements trying to explain that $\frac{0}{0}$ really means something; for he says, p. 11, "The assertion that $\frac{0}{0}$ can, under any circumstances, equal any real number or quantity, will require a good deal of proving before we can accept it. Nevertheless, this is a part of the task I have set myself for the next article."

Again, one blunder of more than ordinary importance is the statement that a convergent series is "a series whose terms diminish indefinitely" (foot-note, p. 52).

Nevertheless, the author's style is clear and easy, his illustrations well chosen and applied, and his reasoning easy to follow.

The author prefers the term "differential coefficient" to the more compact term "derivative," and uses the notation "differential coefficient$_n$" for the nth derivative instead of the more usual form $\frac{d^n y}{dx^n}$.

The first three chapters are devoted to fundamental ideas, the next s': to deducing the rules for differentiation, the tenth to successive differentiation, the eleventh to the graphical meaning of the derivative in rectangular coördinates, and the final chapter to maxima and minima. There are no problems other than those worked out and used in illustrations—a decided drawback even to the reader who seeks only the slightest knowledge of the subject.

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AN APPRECIATION OF TWO GREAT WORKERS IN HYDRAULICS—Giovanni Battista Venturi and Clemens Herschel. By Walter G. Kent. London: Blades, East & Blades. [Privately printed]. Cloth; 7x10 in.; pp. 34; illustrated.

This book is an excellent contribution to the history of engineering. In the literature of the profession there is, comparatively speaking, very little on record concerning the personality of the men who have been responsible for noteworthy achievements in engineering. One difficulty is, of course, that the world only wakes up to find out that a man has done something deserving of recognition after the man himself has passed away, as have those who knew him in his days of active life. Another difficulty is that in the rush and hurry of this Twentieth-Century life we are too busy making history to stop either to write or to read history.

It is all the more deserving of notice, therefore, when a man does take time from earning his bread and butter to write and publish books dealing with engineering history, Mr. Kent, the author of this book, is the manufacturer who has, under Mr. Herschel's patents, furnished Venturi meters to all other countries than North America. He went to great pains in his search for data regarding Venturi's life and history and only by long and persevering search did he succeed. The portraits in the book deserve special praise for their high artistic excellence. While the book is privately printed and not for general circulation, we hope that copies will be obtained and put on file in the principal engineering libraries.

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A Teaching Exposition of the Art of Electric Lighting

ELECTRIC LIGHTING AND MISCELLANEOUS APPLICATIONS OF ELECTRICITY—A Textbook for Technical Schools and Colleges. By William Suddards Franklin. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 6x9 in.; pp. 299; 200 text figures. $2.50, net.

The author has presented a teachers' exposition of the art of electric lighting, different from those texts which are already recognized as desirable standards in the instruction of technical students. He has, to a negligible extent, infringed on the territory so well covered by books like Prof. Crocker's two volumes on "Electric Lighting." It will be recalled that Prof. Crocker in his treatise started out with the history of electric lighting, following that up with a description of the present system of electric units previous to giving a classification of different systems of artificial lighting with electric current. It will be recalled also that he discussed the proper location of generating plants and the arrangement of buildings and machinery. A considerable portion of Prof. Crocker's treatise is given over to the mechanical engineering of power plants, comprising such items as steam engines, steam boilers, power-house piping, gas producers and gas engines, waterwheels and turbines, etc. Then he went into the design of electric-generating equipment, both electrically and mechanically, as the best way of leading up to the more purely electrical side of the art. The second volume of Prof. Crocker's treatise, as will be remembered, largely concerned itself with systems of distribution, discussions of alternating-current phenomena and apparatus, practical details of underground construction work, the construction and use of arc lamps, incandescent lamps, meters, etc.

Prof. Franklin's text is evidently prepared from a very different viewpoint, since he emphasizes, everywhere possible, the influence of economical considerations on design, giving only very minor space to descriptions of apparatus and expositions of design. At the start he outlines the items into which the cost of generating electric power may be divided, and in setting forth these classifications he takes data which have been made available by different engineers to illustrate his divisions. He has thus opened up immediately that field of discussion which the engineer must enter as soon as he undertakes practical work in the electric-lighting industry, particularly in this latter day when the reasonableness of rates and the actual cost of furnishing energy becomes so important in the relations of a company to its patrons and to public regulating commissions.

The theoretical elements of any schedule of rates are considered: items such as (1) a fixed charge to cover cost of metering, billing, etc.; (2) a minimum charge to cover investment behind readiness to serve, and (3) a charge for energy actually consumed. The author also emphasizes simplified schedules and shows the conditions under which simplification is possible even to the extreme of doing business under flat rate. Between the rate discussions and a summary of the financial and engineering operations of the

municipal electric-supply plant of Wellington, Conn., there are sandwiched in some very brief descriptions of electric-energy meters.

The second and third chapters comprise work on distribution and transmission—taking up theoretical discussions of circuits and some more important practical details, such as stresses in catenary sags, pole-line construction, insulators, etc. Chapters IV to VII, inclusive, are largely given over to what we would call nowadays "illuminating engineering." This includes the older fundamental ideas behind the art and science of photometry and the newer material on planning the illumination of specific exterior and interior locations. The absorption method of finding the amount of light and electric energy required for a given scheme of interior illumination has been employed to good advantage, giving the student at one and the same time a clear, easily grasped idea of the actions which go on, and a short easy method for finding the average value of illumination.

In the latter part of the book, Prof. Franklin has departed somewhat from electric lighting to include much matter of a general interest in teaching electrical engineering and of, perhaps, some remote connection with electric lighting. For instance, there is a chapter on "electrolysis and batteries," in which he gives a very readable and interesting review of the modern conception of electro-chemical theories. This leads up to descriptions of a few more important primary cells and to the lead and nickel-iron storage batteries. Finally, he compares the cost of securing current from primary batteries and mechanical generators, that the student may see how chemical generation must cost from $1.50 to $4 per kw.-hr. It is well that the student should realize such facts early in his study, and such specific analyses as here given should give a transferable impression.

There is a chapter on "miscellaneous applications," in which are found some very elementary descriptions of the theory of simple and multiplex telegraphy, submarine signaling, telephony (including the use of loading coils), railway signaling, etc. There are two appendices, one of which presents the subject of electric stresses much in the same way as is done in the author's previous books. A second appendix gives a number of problems which may be used with the various chapters.

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Mexican Cyanide Practice

Reviewed by F. W. TRAPHAGEN*

CYANIDE PRACTICE IN MEXICO—By Ferdinand McCann. San Francisco: Mining and Scientific Press. London: The Mining Magazine. Cloth; 6x9½ in.; pp. 194; 39 text illustrations. $2, postpaid.

The literature of the cyanide process has been greatly enriched by the recent issue of several books dealing with this subject, some of them taking up in great detail the practice followed in special localities. The book under review comes in the latter class, and, dealing with the practice in Mexico, where silver is almost always present in considerable quantity, and where the adaptation of the process to the treatment of gold-silver ores in which the silver is combined as sulphide, sulpharsenide or sulphantimonide, forms not readily amenable to simple cyanidation, has been successfully carried out, it will be welcomed by those interested in the treatment of such ores.

After a brief review of the history of the cyanide process and a general discussion of the various methods of treatment, the practice is described in detail as carried out at 11 different plants. In addition there are chapters on Cyanide Practice in Small Plants, Continuous Cyanide Treatment, Cyanidation in Pan-Amalgamation Mills without Change in the Machinery, Precipitation with Metallic Zinc, and Treatment of Cyanide Precipitates.

Descriptions of the various plants are very complete and being accompanied by details of capacities of various machines and devices, consumption of chemicals and costs of operations cannot fail to be of great value to those concerned with the treatment of ores similar to the Mexican ores treated by these different companies.

It is interesting to note differences in Mexican and South African practice. In Mexico, as well as in other parts of America, Chilian and Huntington mills are in very general use as intermediate or final crushers, while in South Africa stamps follow breakers and all fine crushing is done in tube mills. The logical practice would seem to be, except where battery amalgamation is required, to use breakers, rolls, or ball mills without screens, followed by tube mills.

Classification, or rather sand-slime separation, is made in South Africa almost exclusively by means of [illegible]classifiers, more recently with the addition of the Caldeco[illegible] diaphragm. In Mexico, mechanical classifiers are in general [illegible] the drag-classifier, the Archimedean screw type or the [illegible]r scraper type being the forms preferred.

Filtration of slime in Africa is conducted [illegible]ith filter presses or more generally with vacuum filters, [illegible]though decantation renders filtration unnecessary in ma[illegible]lants. In Mexico vacuum filters, pressure filters, with, [illegible]asionally, filters of the Merrill type are used.

The flow sheet of the Esperanza practice is [illegible] excellent and the "Data Relative to Various Cyanidation [illegible]nts," compiled by W. E. Hindry, contains in small compa[illegible]s a great amount of valuable information.

The metallurgists who have worked out the treatment of these Mexican ores have done a very valuable service and Mr. McCann is to be congratulated for his work in making available in compact form the result of these labors.

Unfortunately, there are a number of errors, mainly typographical, which have escaped the proof reader. Among many are the following: "stop-clock," page 130, "drip cork," page 129, 92,656 pesos instead of 2.656 pesos treatment cost on page 36. There is a redundancy in "decanted off," page 15.

Chemists and metallurgists generally will question the accuracy of the following statement and reaction: "Alkali, in the presence of oxygen, may dissolve zinc forming potassium zincate and hydrogen peroxide, according to the following reaction:

$$Zn + 2\ KOH + O_2 = K_2ZnO_2 + H_2O_2"$$

It is generally believed that the reaction was rather one of reduction:

$$Zn + 2\ KOH = K_2ZnO_2 + H_2$$

The reviewer wonders where McCann finds authority for the reaction as he gives it.

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Military and Tropical Hygiene

MILITARY HYGIENE AND SANITATION—By Col. Charles H. Melville, M. B. Edin., D. P. H.; Royal Army Medical Corps; Late Sanitary Officer, Army Headquarters, India. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 5½x9 in.; pp. 418; numerous tables and diagrams. $3.50, net.

AIDS TO TROPICAL HYGIENE—By Major R. J. Blackham, D. P. H. (London): Divisional Sanitary Officer, First Division, Indian Army. New York: William Wood & Co. Cloth; 4¼x6½ in.; pp. vii + 192. $1.25, net.

If those portions of Colonel Melville's book which deal with the more strictly military phases of his subject are as good as those which have to do with sanitation, and we have no reason to doubt that they are, then he has produced an unusually good treatise. The volume is founded on lectures delivered by the author while Professor of Hygiene at the Royal Army Medical College, and is marked throughout with a rare combination of scientific knowledge and judgment with practical good sense.

Besides such topics as the physical condition and training of recruits, marching, and the food, rations, clothing and equipment of the soldier, the book deals at considerable length with sanitary organization, water-supply and purification, ventilation, removal and disposal of various wastes, the design and care of barracks and of less permanent military habitations, the prevention of infectious diseases, disinfection and the sanitation of the battlefield.

In general, subjects which have been treated over and again in other texts and which are not materially different in private and military sanitation, like plumbing, sewerage and sewage treatment, are briefly dismissed—a most praiseworthy feature of the book.

From the military viewpoint, the removal of sewage and of night soil is rightly considered as of greater importance than their disposal. For night soil and garbage, burning as near as reasonably may be to the point of origin is advocated. Feces and urine from persons known to be infected with typhoid fever, in the author's opinion, should be disinfected by boiling. Experience in India points to comparatively little danger of typhoid from water-supplies, up to the point of distribution to individual users, but the greatest care in distribution from tanks or water taps by human water carriers, particularly by Indian natives, is urged.

Hypochlorite water disinfection is not given the fullness of consideration or the value which it seems to merit, but the British are conservative in this respect. The author does not seem to hold the septic tank in high esteem, and does not even mention the Imhoff tank. The latter failure, again, is in line with British conservatism. We hasten to add, however, that no general accusation of British or other conservatism or insularity would hold good against the author. He shows

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a breadth of information and judgment alike, which is not common to British writers.

Colonel Melville's book as a whole deserves hearty commendation. We should suppose that it might be useful to army officers responsible for the health of soldiers, and the sanitation of camps in any part of the world, although it seems to be founded largely on East Indian conditions. The book also contains many practical suggestions and even specific data of possible use to any one in charge of engineering and construction camps, besides abounding with ideas that cannot fail to interest the student of general hygiene and sanitation.

Major Blackham, in his "Aids to Tropical Hygiene," has compressed into small compass a large amount of useful information. Both personal hygiene and general sanitation are treated. The chapters on water purification and sewage treatment betray a superficial knowledge of these subjects and contain a number of misleading statements. The section on the disposal of household refuse is brief and unsatisfactory.

All three of these subjects are treated with a brevity and shallowness that is in striking contrast with the three chapters on Insects and Disease, Animal Parasites and Prevention of Malaria. Considering the small size of the book these subjects are treated in great detail. It is questionable whether in a "Students Aids Series" there is occasion for going so minutely as has this author into the natural history of the various mosquitoes and flies described. If such detail is required it would seem to be better either to refer the students to larger and special treatises, if such exist, or else to add to this series a book dealing with these subjects alone.

Notwithstanding the foregoing criticisms, Major Blackham's little book has much to commend it. Particularly good is a folding sheet at the end of the book containing a tabular summary of "Tropical Diseases Indicating Preventive Measures."

Radioactivity

Reviewed by CHARLES BASKERVILLE*

STUDIES IN RADIOACTIVITY—By W. H. Bragg, M. A., F. R. S., Cavendish Professor of Physics in the University of Leeds; formerly Elder Professor of Mathematics and Physics in the University of Adelaide. New York: The Macmillan Co.; London: Macmillan & Co., Ltd. Cloth; 6x9 in.; pp. 196; 70 text figures; $1.60, net.

All students of radiochemistry are familiar with the experimental investigations of Bragg and of Bragg and R. Kleeman on, mainly, the phenomena attending the passage of the alpha-, beta-, gamma- and X-rays through matter, as published in the "Philosophical Magazine" during the past eight years. Bragg and Kleeman first attacked certain questions in the study of radioactive transformations in 1904, and the interesting experiments performed by them and the conclusions which they arrived at therefrom have thrown light on the nature of the alpha-rays and on the laws of their absorption by matter, on the scattering of the beta-ray and its loss of energy, and on the nature and properties of the X- and gamma-rays.

In this volume Bragg deals with the subjects which he has investigated, in response to a request that he prepare an account of his experiments and conclusions. He has not, however, confined the book within the limits of his own enquiries, but has included the field in which his investigations have been conducted. While this field may be regarded as but a limited portion of the domain of radiochemistry, as pointed out by the author himself, yet the attempt to give a presentment of the important features of a special subject and to collate the things which most invite comparison has been successful, and the book will undoubtedly serve a useful purpose in conveniently supplying the results of special studies in an important field of radioactivity. It is divided into 17 chapters and includes a good index.

It must be borne in mind that the book deals exclusively with certain phases of the physical side of radioactivity. Consequently, considering that the chemical side is of equal importance, the general reader—in fact, all others than radiochemists and physicists who have specialized in radioactivity—will lay down the work with a feeling that he has only heard part—an intermediate part—of a serial; but it may be cordially recommended to the advanced student of chemistry and physics of the radio-elements.

The work is well printed on substantial paper. There are very few misprints.

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REINFORCED-CONCRETE CONSTRUCTION — Advanced Course, with Numerous Fully Worked Examples. By M. T. Cantell, Licentiate, R. I. B. A., Head of Architecture and Building Department, Municipal Technical College, Brighton. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 7x10 in.; pp. xi + 240; 251 illustrations, including 7 folding plates. $5.

English engineers are just beginning to realize that the design and construction of reinforced concrete is not a secret process known only to a certain limited guild, to which all general practitioners must turn when reinforced concrete is to be used. While the various "systems" still have a greater prestige in Great Britain than in any other country, the growing number of British books on reinforced concrete shows that there is a demand among engineers for more information as to design, which information, it is to be hoped, will be used in original designing rather than in checking. However, the comparative novelty of such books explains the elementary form that most of them take. Occasionally an English book on concrete is supertechnical; such a book, for instance, is Faber & Bowie's "Reinforced-concrete Design" (reviewed here on June 13, 1912, p. 1151), but in general they are devoted only to the most simple phases of concrete design.

The book before us is called an "Advanced Course," and follows a previous "Elementary Course," and yet it takes up only the simplest design and the stock forms of construction. It further follows the elementary types of text in numerous numerical examples which are used to illustrate the occasional general principles. An examination of the book, however, shows this to be a most admirable method of instruction, and one that could be profitably followed in other texts. The beginner can always more readily understand a specific example than a general formula.

A German Treatise on Oil Engines

OELMOTOREN IN VIERTAKT- UND ZWEITAKTBAUART—By H. Haeder, Ingenieur. Vol. I. Bauarten, Wirkungsweise, Berechnung und Konstruktionseinzelheiten der Motoren und Motorenteile. Cloth; 4¾x8 in.; pp. xvi + 255; 460 text figures. Vol. II. Hauptmasse, Masstabellen, Diagramme, Versuchsergebnisse, Berechnungen, Gewichte, Preise, Aufgaben und Beispiele. Cloth; 9x8 in.; pp. viii + 108; numerous text figures, 58 plates. Wiesbaden: Otto Haeder. Vol. I, 5 marks. Vol. II, 13.50 marks. Complete, 18.50 marks.

An examination of these volumes impresses one at once how far Europe is in advance of this country in the design and construction of internal combustion engines. We note with regret, also, that it is likewise far in advance of this country in the extent to which publicity is given to the art of mechanical design. It would be easy to criticise these volumes by saying that they are to a considerable extent a compilation of matter, which has previously appeared in technical publications and in trade catalogs. The work is not to be compared, of course, it will be admitted, to the monumental treatise of Güldner on internal-combustion engines. On the other hand, it is also true that these volumes are filled with just the sort of information that the practical designer of oil engines desires to have. There is a profusion of detailed drawings of oil engines of many sizes and types and especially of their details. These drawings are in many cases quite fully dimensioned, and, while reduced to a comparatively small scale, they are still of great use to the designer.

It would be absolutely impossible to publish such a book in the United States, even if the oil-engine industry were advanced to as high a stage of perfection in this country as it is in Germany. There is a prevalent idea in this country that European manufacturing concerns are much more secretive in their policy than American concerns. There is this much foundation for the idea: It is generally much more difficult for an engineer to obtain access to a European engineering works than to a similar works in the United States. In Germany and France. On the other hand, the art of mechanical design is immensely stimulated and aided by the extensive publication of detailed drawings of machinery in technical journals, and in such books as the one before us. The American editor of a technical journal or the American writer of a technical treatise who attempts to secure from American manufacturers anything in the way of detailed drawings of the machines which they build invariably finds that he has run square against a stone wall.

We believe that this mistaken attitude of American manufacturers has very much to do with the backward state of mechanical-engineering design in this country as compared with Europe. The men in each establishment in America are working independently with no knowledge of what is being done by others in the same field except as it is picked up more or less surreptitiously. It is a fact that designing en-

gineers in many American shops make extensive use of foreign publications such as this before us, and must do so, indeed, if they are to keep at all up to date.

The recent development of the oil motor in Europe has been remarkable. In the United States the era of cheap gasoline has lasted so long that only a very few firms have bothered themselves at all over the design of motors burning kerosene or heavier oils. In Europe, however, there is a great variety of oil engines produced by many different manufacturers, in all sizes from small machines of a few horsepower up to the large Diesel engines of 1000 to 2000 hp. Their construction has become as well established an industry in Europe as has the production of ordinary steam engines in the United States. With the rapid increase in the consumption of gasoline in this country and the steady increase in its price, which is inevitable in the future, there is certain to be a great demand for successful oil engines in the United States. Careful study of European designs will enable American manufacturers to save the expenditure of much money in useless experiments.

Studies of Aviation

Reviewed by WILLIAM McENTEE*

THE MECHANICS OF THE AEROPLANE—A Study of the Principles of Flight. By Captain Duchene. Translated from the French by John H. Ledeboer, B. A., Associate Fellow, Aëronautical Society; Editor "Aëronautics," Joint-Author of "The Aëroplane," and T. O'B. Hubbard, Secretary of the Aëronautical Society; Joint-Author of "The Aëroplane." New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. x + 231; 91 text figures. $2.25, net.

STABILITY IN AVIATION—An Introduction to Dynamical Stability as Applied to the Motions of Aëroplanes. By G. H. Bryan, Sc. D., F. R. S.; Professor of Pure and Applied Mathematics in the University College of North Wales, formerly Fellow of Peterhouse, Cambridge. New York and London: The Macmillan Co. Cloth; 6x9 in.; pp. 192; 38 text figures. $2, net.

The author of "The Mechanics of the Aëroplane" is Captain of Engineers in the French Army. In 1911, according to the Translators' Preface, the French Academy of Sciences awarded him the Monthyon prize, in recognition of his production of the original of this "Study."

The book is designed to supply a demand for an explanation of the principles of mechanical flight in such form that an education in abstruse mathematics will not be required in order to read it intelligently. At the same time, it does not seek to convey the essential element of the subject in a way which can be said to be popular, or make an appeal to a wider circle of readers by sacrificing mathematical accuracy of statement in an attempt to convey in words facts which are best expressed in formulas. The author has, on the whole, succeeded in avoiding abstruse mathematics on the one hand and loose popular form on the other. The subject is presented so that it will readily be understood by the reader who has a good high-school education.

The volume is divided into four parts. Part I consists of 100 pages, dealing with flight, both horizontal and oblique, in still air. In Part II, 65 pages are devoted to the question of stability. Parts III and IV deal with the effect of the wind and with the screw propeller, respectively, taking together some 43 pages. At the end of the book are given 9 pages of tables which are useful for those making aërodynamic computations, and particularly so if conversions from the metric to the English system are involved.

On page 2 the statement is made, in discussing the subject of air pressures on inclined planes, that "the magnitude of the pressure is proportional to the square of the velocity." On the opposite page, it is stated that "the pressure is proportional to the velocity." This is apparently a slip by the author or translators.

It is perhaps unfortunate that the angle of incidence is expressed in terms of the natural sine instead of degrees. Though convenient for computations, it is confusing because of the more general use of the latter for this purpose. The author himself finds it necessary in many places throughout the book to state the angle in both forms.

On page 8, the aërodynamic constant, or pressure coefficient, K, is stated to be characteristic of the "lifting efficiency" of a plane or curved surface, and it is therefore called throughout the book the "lifting efficiency." This is a curious confusion of the terms "efficiency" and "capacity." The "efficiency" of an aëroplane is greatest when the ratio of lift to drift is greatest. It does not necessarily follow that under this condition its weight-carrying ca[illegible]ity is also greatest.

This confusion of terms leads, in a lengthy [illegible]ssion of the relations between weight, speed, angle of i[illegible]nce and value of K, to what is called, on page 19, "a[illegible]t sight . . . . the astonishing result that . . . [illegible]e aëroplane possessing the most inefficient planes will [illegible]he fastest." Instead of changing the error producing na[illegible]given to the constant K, the author remarks that the a[illegible]ntage is only apparent and that the increase in speed is o[illegible]ained at an excessive cost in power. This part of the wo[illegible]could be recast to advantage.

With the exceptions noted, Part I is well presented.

Passing on to Part II, dealing with equilibrium and stability, one is struck by the assertion that it is erroneous to liken the equilibrium of an aëroplane to that of a boat, and still more so by the attempted proof of that assertion, the proof being based on the assumption that when equilibrium is disturbed the center of effort and direction of action of the supporting forces is such that their line of action passes through the center of gravity of the aëroplane in all cases. Under such circumstances, there could, of course, be no righting moment tending to right the machine. The proof, however, is a clear case of arguing in a circle. In a foot note, it is stated that this assertion applies only to transverse equilibrium. As a matter of fact, it is only true in the very exceptional case when the center of effort of the supporting forces coincides exactly with the center of gravity of the aëroplane. In the subsequent discussion of the subject, formulas are derived for longitudinal stability, which are exactly analogous to those used to express the stability of a ship.

The treatment of the propeller problem in the last part of the book is not very impressive. The formula

$$T = b\ V^2\ D^2,$$

giving the relation between thrust, speed of advance through the air, and diameter of the propeller required, is simple and can be used with excellent results, if the value of the constant b is taken with due regard to type and pitch ratio.

The statement on page 215 that a pitch ratio of 3.14 is desirable for efficiency is contrary to results of experiments both with air and water propellers, which agree in showing a pitch ratio of about 1.5 to be best.

The rather guarded opinion expressed as to the probable superior efficiency of 4-bladed as compared with 2-bladed propellers is also at variance with experimental results.

In "Stability in Aviation," Prof. Bryan is frankly a mathematician, working with the mathematician's tools in the field of aëronautics.

In a novel and interesting "Introduction and Summary," comprising the first 18 pages of the book, the author sets forth his reasons for undertaking the present work, as follows:

> In this book attention is concentrated on the mathematical aspect of the problem for several reasons. In the first place, there is no obvious alternative between developing the mathematical theory fairly thoroughly and leaving it altogether alone; any attempt at a via media would probably lead to erroneous conclusions. In the second place, the formulæ arrived at, even in the simplest cases, are such that it is difficult to see how they could be established without a mathematical theory. In the third place, there is probably no lack of competent workers interested in the practical and experimental side of aviation, and under these conditions it is evident that the balance between theory and practice can be improved by throwing as much weight as possible on the mathematical side of the scale. Lastly, it is hoped to advocate the claims of aëroplane equilibrium and stability as an educational subject suitable for study in our universities alongside with such branches of applied mathematics and mathematical physics as hydrodynamics, and particle and rigid dynamics.

And as if the forces at work on the theoretical side were in need of recruits, this is followed by an invitation to other mathematicians to join in the exploration of the new field, where it is promised that many problems await solution.

There is no doubt that there is need of rigid theoretical investigations of the forces involved in the subject. Theorists should therefore be encouraged to extend their investigations to the mathematical limit, so to speak. If the conclusions arrived at agree with observed facts, they supply a logical explanation of them. If they do not agree with the facts, so much the worse for theory, and no harm has been done.

The author first deduces the six general equations of motion, as used in Rigid Dynamics. These are applied under various assumed conditions of equilibrium and disturbed equilibrium, the result being a maze of mathematics, in which a number of transformations and assumptions as to importance of neglected terms are necessary, in order to simplify the results sufficiently to make them capable of indicating any particular conclusion.

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The danger of the method is that in the process of simplification certain assumptions may be admitted which eventually lead to error. For example, on page 53, under what is called the "Principle of Independence of Height," it is concluded that "if an aëroplane is stable when the planes are on a level with the center of gravity, the stability is only very slightly affected by raising or lowering the planes." This appears doubtful. On a "Wright" aëroplane a considerable initial transverse stability is obtained by placing the center of gravity of the machine with passengers about 12 in. below the center of support. If the center of gravity were raised 18 in., the aëroplane would certainly become initially unstable as concerns transverse inclinations.

The book as a whole appears to be equal to the best known previous work of the same class, published in English, that is Lanchester's "Aërodonetics" (London, 1908). The methods employed in the two are radically different, but the conclusions reached in each, on points of fundamental importance, are in substantial agreement. The present work may be said to have made some advance over the other, in that it takes account of the secondary and more rapid longitudinal oscillations of an aëroplane, and shows them theoretically to be of little importance.

Applied Statics

Reviewed by AMASA TROWBRIDGE*

TEXTBOOK OF MECHANICS—By Louis A. Martin, Jr., Professor of Mechanics, Stevens Institute of Technology. Vol. IV. Applied Statics. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7⅞ in.; pp. xii + 198; 141 text illustrations. $1.50, net. (6/6, net).

A small book for a very broad subject. In fact, so small that only an outline is given. The author's effort to make a "teachable" book has been crowned with success for, without a teacher, the student would certainly find the path of knowledge quite difficult in some places. The plan of the book is the same as in Volume III; the student is required to deduce his formulas with the least possible aid from the textbook. Without doubt, this is bound to make him think and to give him a more thorough understanding of the subject than would be gained by merely memorizing. The scheme is decidedly a good one.

The subject of Applied Statics is so broad that one could not expect to cover it in a small textbook. The author has selected what he considers the essentials and has treated them as fully as his space permitted. The free use of problems has enabled him to introduce many points not covered by the text, which the student is expected to dig out for himself. A set of review problems at the end of the book serves to connect the subject treated to the problems which an engineer might meet and which may be readily solved by the methods and formulas given in the text.

The author begins with a very concise chapter on Work and Energy. He introduces many machine elements, but confines the treatment to the "static" condition. He next gives a condensed discussion of Coplanar Forces as these are the basis of much of the work in Chapter III, which treats of two-dimensional structures. These are the forms of framed structures most frequently used. Then follows a chapter on Solid Statics, these being applied to the solution of the stresses in sheer legs and steam-shovel frames. Chapter V treats briefly of the Equilibrium of Ropes and Cables. Friction is introduced in Chapter VI, the treatment of the subject being mostly graphical. This is amplified by a consideration of the Forces Acting on Machine Members and Complete Machines. The final chapter deals with Resistance to Rolling.

Volume I of this series on Statics, was reviewed in these pages on July 12, 1906; Volume II, on Kinematics and Kinetics, Dec. 12, 1907; and Volume III, on Mechanics of Material, Nov. 16, 1911.

MODERN PARK CEMETERIES—By Howard Evarts Weed, M. S., Landscape Architect. Chicago, Ill.: R. J. Haight. Cloth; 5x7½ in.; pp. 145; 21 text illustrations. $1.60, net.

Within brief compass the author has succeeded in giving a good, general idea, as well as some practical information, on the principles which should be followed in laying out and managing any cemetery and particularly those which depart from the old-time rigid geometrical lines and real-estate conception of providing as many salable lots as possible, and in place follow the principles governing good landscape work. The book contains, among other things, practical hints on grading, planting, lawn-making, and construction of roads. The latter subject is treated by Myron H. West, superintendent of Lincoln Park, Chicago. A few line drawings and a number of well selected and well produced halftone photographs add to the interest and value of the book.

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PUBLICATIONS RECEIVED

ALMANAC FOR 1913—Baltimore, Md.: The "Sun." Paper; 5x7 in.; pp. 256.

ALTERNATING-CURRENT MACHINERY—A Practical Treatise on Alternating-current Principles and Systems, Commercial Types of Alternators, Synchronous Motors, Transformers, Converters, Induction Motors, Switchboard and Station Appliances, etc. By William Esty, S. B., M. A., Head of Department of Electrical Engineering, Lehigh University. Chicago: American School of Correspondence. Cloth; 6¼x9¾ in.; pp. xii + 467; 409 text illustrations. $3.

AMERICAN CITY GOVERNMENT: A SURVEY OF NEWER TENDENCIES—By Charles A. Beard, Associate Professor of Politics in Columbia University. New York: The Century Co. Cloth; 5¼x8¼ in.; pp. 420; 14 illustrations. $2. net.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION—Proceedings for 1912. [Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago.] Cloth; 6x9 in.; pp. 432; illustrated.

AMERICAN WATER WORKS ASSOCIATION—Proceedings for 1912. Troy, N. Y.: John M. Diven, Secy. Cloth; 6x9 in.; pp. 465; illustrated.

BIBLIOGRAPHY OF NORTH AMERICAN GEOLOGY FOR 1911, with Subject Index—John M. Nickles. Bulletin 524, U. S. Geological Survey (George Otis Smith, Director). Washington, D. C.: Pub. Doc. Paper; 5¾x9¼ in.; pp. 162.

BOARD OF RAILROAD COMMISSIONERS OF IOWA—Report for 1911. Des Moines. Cloth; 6x9 in.; pp. 790.

THE CANE AS A WEAPON—By A. C. Cunningham, Civil Engineer, U. S. Navy. Washington, D. C.: The Army and Navy Register. Stiff paper; 4½x6 in.; pp. 55; illustrated. 50c.

CARE OF TUBERCULOSIS WAGE EARNERS IN GERMANY—Washington, D. C.: U. S. Bureau of Labor. Paper; 5¾x9¼ in.; pp. 133.

CENSUS OF THE CANAL ZONE, Feb. 1, 1912—Taken by the Department of Civil Administration. Mount Hope, C. Z.: Isthmian Canal Press. Paper; 5½x8¾ in.; pp. 58.

CHEMICAL ARITHMETIC AND CALCULATION OF FURNACE CHARGES—By Regis Chauvenet, M. Am. Inst. Min. E. Philadelphia and London: J. B. Lippincott Co. Cloth; 6x9 in.; pp. xi + 302; $4, net.

CLEAR LAKE WATER SUPPLY for State Institutions, Cities and Towns in Upper Willamette Valley—Report of Louis C. Kelsey (Portland, Ore.) to Oregon State Board of Health. Paper; 6x9 in.; pp. 39; illustrated.

A news note summarizing this report may be found on p. 187 of Eng. News of Jan. 23, 1913.

COMMISSIONER OF HEALTH OF VIRGINIA—Report of Ennion G. Williams, M. D. (Richmond, Va.), for 1912. Paper; 6x9 in.; pp. 200.

CONCENTRATING ORES BY FLOTATION—Being a Description and History of a Recent Metallurgical Development, Together with a Summary of Patents and Litigation. By Theodore J. Hoover, A. B., Leland Stanford, Jr., University; M. Inst. M. & M. London: The "Mining Magazine." San Francisco.: Mining & Scientific Press, Agents. Cloth; 6x9 in.; pp. 221; 55 text illustrations. $3.75.

CONTROL OF WATER CARRIERS BY RAILROADS AND BY SHIPPING CONSOLIDATIONS, PART IV—Report of Commissioner of Corporations Luther Conant, Jr. (Washington, D. C.), on Transportation by Water in the United States. Paper; 6x9 in.; pp. 101; illustrated.

COSTS OF PRODUCING POWER IN IOWA WITH IOWA COALS—By H. W. Wagner. Bulletin 29, Engineering Experiment Station, Ames, Iowa. Paper; 6x9 in.; pp. 36; illustrated.

THE ECONOMICS OF RAILROAD CONSTRUCTION—By Walter Loring Webb, M. Am. Soc. C. E., Assistant Professor of Civil Engineering (Railroad Engineering), University of Pennsylvania, 1893-1901. Second edition, thoroughly revised. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. viii + 347; 34 text figures. $2.50 (10/6), net.

ELECTRICAL MACHINE DESIGN—The Design and Specification of Direct and Alternating Current Machinery. By Alexander Gray, Assistant Professor of Electrical Engineering, McGill University, Montreal, Can. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 528; 317 text illustrations. $4, net.

ELECTRICITY IN INDIA—Being a History of the Tata Hydro-Electric Project, with Notes on the Mill Industry in Bombay and the Progress of Electric Drive in Indian Factories. Edited by S. M. Rutnagur. Bombay, India: "Indian Textile Journal." Paper; 6x9 in.; pp. 80; illustrated. Rs. 1-12.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS—By Albert F. Ganz, Professor of Electrical Engineering, Stevens Institute of Technology, Hoboken, N. J. Reprinted from Proceedings American Water Works Association. Paper; 6x9 in.; pp. 40; illustrated.

ELEMENTS OF HEAT-POWER ENGINEERING—By C. F. Hirshfeld, M. M. E., Professor of Power Engineering, and Wm. N. Barnard, M. E., Professor of Steam Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6[illegible]in.; pp. xiii + 811; 480 text figures. $5 (21s.), net.

ELEMENTS OF WESTERN WATER LAW—By A. E. Chandler, Irrigation and Water Right Specialist; Assistant Professor, Irrigation Institutions, University of California; Secretary, American Engineering Corporation, San Francisco. San Francisco: Technical Publishing Co. Cloth; 6x9 in.; pp. 150. $2.

ESSENTIALS OF ELECTRICITY—A Textbook for Wiremen and the Electrical Trades. By W. H. Timbie, Head of Department of Applied Science, Wentworth Institute, Boston, Mass.; formerly Instructor in Industrial Electricity, Pratt Institute. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7 in.; pp. xiii+271; 224 text figures. $1.25, net (5/6, net).

FOREST FIRES: Their Causes, Extent and Effects, with a Summary of Recorded Destruction and Loss—By Fred G. Plummer, Geographer. Bulletin 117, Forest Service, U. S. Department of Agriculture. Washington, D. C.: Pub. Doc. Paper; 6x9¼ in.; pp. 39; 1 plate and 6 text figures.

THE GASOLINE ENGINE ON THE FARM—A Practical, Comprehensive Treatise on the Construction, Repair, Management and Use of this Great Farm Power as Applied to All Farm Machinery and the Farmer's Work Indoors and Out. By Xeno W. Putnam. New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 527; 179 text illustrations. $2.50.

GEOLOGY OF THE OIL AND GAS FIELDS OF WICHITA AND CLAY COUNTIES, TEXAS—By J. A. Udden, Geologist of the Bureau of Economic Geology and Technology, assisted by Drury McN. Phillips. Austin: The University of Texas. Paper; 5⅝x9 in.; pp. 308; illustrated.

THE GOVERNMENT OF AMERICAN CITIES—By William Bennett Munro, Ph. D., Professor of Municipal Government, Harvard University. New York: The Macmillan Co. Cloth; 5⅜x9 in.; pp. 401. $2, net

A HANDBOOK OF ENGLISH FOR ENGINEERS—By Wilbur Owen Sypherd, Professor of English in Delaware College. Chicago and New York: Scott, Foresman & Co. Flexible leather; 4x7 in.; pp. 314. $1.50.

HIGHWAY COMMISSIONER OF WASHINGTON—Report of W. J. Roberts (Olympia, Wash.) for 1911 and 1912. Paper; 6x9 in.; pp. 43; illustrated.

IRON AND STEEL INSTITUTE—Journal for 1912, No. 2, Vol. LXXXVI. London: The Institute (28 Victoria St.) and E. & F. N. Spon. New York: Spon & Chamberlain. Cloth; 5x9 in.; pp. 708; illustrated.

IRRIGATION: ITS PRINCIPLES AND PRACTICE AS A BRANCH OF ENGINEERING—By Sir Hanbury Brown, M. Inst. C. E. Second edition, revised. New York: D. Van Nostrand Co. Cloth; 5x9 in.; pp. xv+301; 68 text figures and several plates. $5, net.

Apparently the present edition of this work is substantially the same as the first one (the number of pages is identical), which was reviewed by F. W. Hound, in our issue of May 14, 1908.

ISTHMIAN CANAL COMMISSION—Report for 1912. Washington, D. C. Paper; 6x9 in.; pp. 640; illustrated.

LEAD AND ZINC OF OKLAHOMA—By L. C. Snider, Assistant Director, Oklahoma Geological Survey. Bulletin No. 9. Norman, Okla.: The Survey. Paper; 6x9 in.; pp. 97; illustrated.

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK FOR 1913—Manchester and London: Emmott & Co., Ltd. Cloth; 4x6¼ in.; pp. 311; 98 text figures. Sixpence.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK FOR 1913—Manchester and London: Emmott & Co., Ltd. Cloth; 4x6¼ in.; pp. 439; 66 text figures. Sixpence.

MELTING POINTS OF FIRE BRICKS—By C. W. Kanolt, Assistant Physicist. Being No. 10, Technologic Papers of the Bureau of Standards (S. W. Stratton, Director). Washington, D. C.: Pub. Doc. Paper; 7x10 in.; pp. 17; illustrated.

THE METRIC SYSTEM IN ALL ITS DETAILS—Compared with the American Weights and Measures. By Henry G. Bayer. 26 tables of Equivalents. The Thermometers. New York: The Author, 232 Greenwich St. Cloth; 4x7 in.; illustrated. 85c.

A very complete exposition of the value of the metric system with a full set of conversion and multiple tables.

MINERAL FUELS—By Marius R. Campbell. Part II of Contributions to Economic Geology in 1910. Washington, D. C.: U. S. Geological Survey. Paper; 6x9 in.; pp. 663; illustrated.

MINERAL PRODUCTION OF CANADA FOR 1911—Ottawa: Department of Mines. Paper; 6½x10 in.; pp. 38.

MINERAL RESOURCES OF THE UNITED STATES FOR 1911—Part II, Nonmetals. Washington, D. C.: U. S. Geological Survey. Cloth; 6x9 in.; pp. 1224; illustrated.

MINING ENGINEERS' EXAMINATION AND REPORT BOOK—By Charles Janin, Consulting Mining Engineer. San Francisco, Calif.: Mining & Scientific Press. London: The "Mining Magazine." Part I, Flexible leather; 5x8 in.; pp. 94; illustrated. Part II, cardboard; 8x5 in.; pp. 57. [Fitted in envelope on back cover of Part I.] Complete, $2.50, postpaid, or Part II, 50c.

NATIONAL ELECTRIC LAMP ASSOCIATION—Abstract Bulletin of the Physical Laboratory. Cleveland: The Association. Paper; 6x9 in.; pp. 127, illustrated.

THE NEW COMPETITION—An Examination of the Conditions Underlying the Radical Change That is Taking Place in the Commercial and Industrial World—The Change from a Competitive to a Coöperative Basis. By Arthur Jerome Eddy, author of "The Law of Combinations." New York: D. Appleton & Co. Cloth; 5¼x8½ in.; pp. 374. $2, net. $2.14, postpaid.

NEW YORK STATE DEPARTMENT OF HEALTH—Report for 1911. Albany, N. Y.: Eugene H. Porter, M. D., Commissioner. Cloth; 6x9 in.; pp. 1232; illustrated.

OHIO ELECTRIC LIGHT ASSOCIATION—Proceedings for 1912. Greenville, Ohio: D. L. Gaskill, Secy. Cloth; 6x9 in.; pp. 206; illustrated.

OKLAHOMA GEOLOGICAL SURVEY—Part I. Director's Biennial Report to the Governor of Oklahoma, 1912. Part II. Mineral Production of Oklahoma from 1901 to 1911. By D. W. Ohern, Director, Norman, Okla. Paper; 6x9 in.; pp. 47.

PEAT DEPOSITS OF OHIO: Their Origin, Formation and Uses—By Alfred Dachnowski. Columbus, Ohio: Geological Survey of Ohio. Cloth; 6x9 in.; pp. 424; illustrated.

POPULAR MECHANICS "SHOP NOTES FOR 1913"—Vol. IX. Chicago: Popular Mechanics Magazine. Stiff paper; 6½x9½ in.; pp. 224; 503 illustrations. 50c., postpaid. Set of nine volumes, $4.50.

PROCEEDINGS OF THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS—Edited by Thomas Cole, Assoc. M. Inst. C. E., Secretary of the Institution. Vol. XXXVIII. 1911-12. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 5½x8¾ in.; pp. xcviii+514; numerous illustrations and folding plates.

PROCEEDINGS OF THE TRAVELING ENGINEERS' ASSOCIATION, 1912—Edited by W. O. Thompson, Secretary, New York Central Car Shops, Buffalo, N. Y. Leather; 5¾x8¾ in.; pp. 469.

THE PROPOSED PATENT LAW REVISION—By Gilbert H. Montague. [Reprinted from the Harvard Law Review, Vol. XXVI, No. 2]. Cambridge: The Harvard Law Review Association. Paper; 6¾x10¾ in.; pp. 17.

PROVINCIAL BOARD OF HEALTH OF ONTARIO—Report for 1911. Toronto. Paper; 6x9 in.; pp. 165; illustrated.

PSYCHOLOGY AND INDUSTRIAL EFFICIENCY—By Hugo Münsterberg. Boston and New York: Houghton-Mifflin Co. Cloth; 5x8 in.; pp. 315. $1.50, net.

THE PUBLIC HEALTH ACT, and THE VACCINATION ACT—Toronto, Canada: Provincial Board of Health of Ontario. Paper; 6½x9¾ in.; pp. 70.

PUBLIC SERVICE COMMISSION OF NEW YORK, FIRST DISTRICT—Report for 1910. Statistics of Gas and Electric Corporations. Cloth; 5½x9 in.; pp. 664 and 760.

RAILROAD CONSTRUCTION—By Charles Lee Crandall, M. Am. Soc. C. E., Professor of Railroad Engineering, and Fred Asa Barnes, M. Am. Soc. C. E., Assistant Professor of Railroad Engineering, Cornell University. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii+321; 79 illustrations. $3, net.

RATIONAL AND APPLIED MECHANICS—By Calvin Milton Woodward, Ex-Dean of School of Engineering and Architecture; Professor Emeritus of Mathematics and Applied Mechanics, Washington University, St. Louis, Mo. St. Louis: The Author, 3013 Hawthorne Boulevard, or Nixon-Jones Printing Co., 215 Pine St. Cloth; 6x9 in.; pp. viii+517; 486 text illustrations. $4.

RECEIPTS AND EXPENDITURES OF ORDINARY REVENUE FOR 1907 TO 1911—Boston, Mass.: Statistics Department. Paper; 9x12 in.; pp. 170.

RETAIL PRICES, 1890 TO JUNE, 1912—Bulletin of the United States Bureau of Labor, Whole Number 106: Part II: [Retail Prices and Cost of Living Series, No. 2: Part II]. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 205.

SAW FILING AND MANAGEMENT OF SAWS—By Robert Grimshaw, M. E. Third edition, revised and enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 4x6½ in.; pp. 133; 106 text illustrations. $1.

STATE BOARD OF HEALTH OF MASSACHUSETTS—Report for 1911. Boston. Cloth; 5½x9 in.; pp. 680; illustrated.

STATE BOARD OF HEALTH OF MICHIGAN—Report for 1911. Lansing. Cloth; 6x9 in.; pp. 118.

THE STOCK EXCHANGE FROM WITHIN—By W. C. Van Antwerp. Garden City and New York: Doubleday, Page & Co. Cloth; 5x8 in.; pp. 457. $1.50, net.

TRANSACTIONS OF THE INSTITUTION OF MINING AND METALLURGY. Session—1911-1912. London: E. & F. N. Spon, Ltd., and the Institution of Mining and Metallurgy. Paper; 5½x8½ in.; pp. 831; illustrated. 21 shillings.

TUBULAR STANDARDS FOR 1913—Pittsburgh, Penn.: National Tube Co. Flexible leather; 4x7 in.; pp. 559; 136 illustrations. $2.

While devoted chiefly to tables applicable to the tubular products made by the publishers, this volume also contains a considerable amount of matter relating to engineering work in which pipes and tubes are used. The book is similar in general scope and object to the well known handbooks published by manufacturers of structural steel, and will be useful in almost any drafting room.

WATER: ITS PURIFICATION AND USE IN THE INDUSTRIES—By William Wallace Christie, M. Am. Soc. C. E., Consulting Engineer; Editor, Mechanical Section of Foster's "Electrical Engineer's Pocketbook." New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. xi+219; 79 text illustrations. $2, net.

WESTERN CANADA IRRIGATION ASSOCIATION—Proceedings for 1912. Calgary, Alta.: Norman S. Rankin, Secy. Paper; 7x10 in.; pp. 198; illustrated.

WIDERSTAND EINBETONIERTEN EISENS GEGEN GLEITEN. EINFLUSS DER HAKEN—By C. Bach, K. Württ. Baudirektor, Professor des Maschineningenieurwesens, Vorstand des Ingenieurlaboratoriums und der Materialprüfungsanstalt an der K. Technischen Hochschule Stuttgart, und O. Graf, Ingenieur der Materialprüfungsanstalt. Berlin: Wilhelm Ernst & Sohn. Paper; 5x7 in.; pp. 31; 16 text illustrations. 1 mark.

WATER-SUPPLY PAPERS—Surface Water Supply of the United States. Washington, D. C.: U. S. Geological Survey. No. 283: Ohio River Basin, 1910. By A. H. Horton, M. R. Hall and H. J. Jackson. Pp. 158. No. 301: North Atlantic Coast, 1911. By C. C. Babb, C. C. Covert and R. H. Bolster. Pp. 221.

THE "WORLD" ALMANAC AND ENCYCLOPEDIA FOR 1913. New York: Press Publishing Co. Paper; 5x8 in.; pp. 896. Single copies, 25c. By mail, 35c.